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ANNOTATED BIBLIOGRAPHY OF WATER OPTICAL PROPERTIES OF OCEAN WAT--ETC(U)
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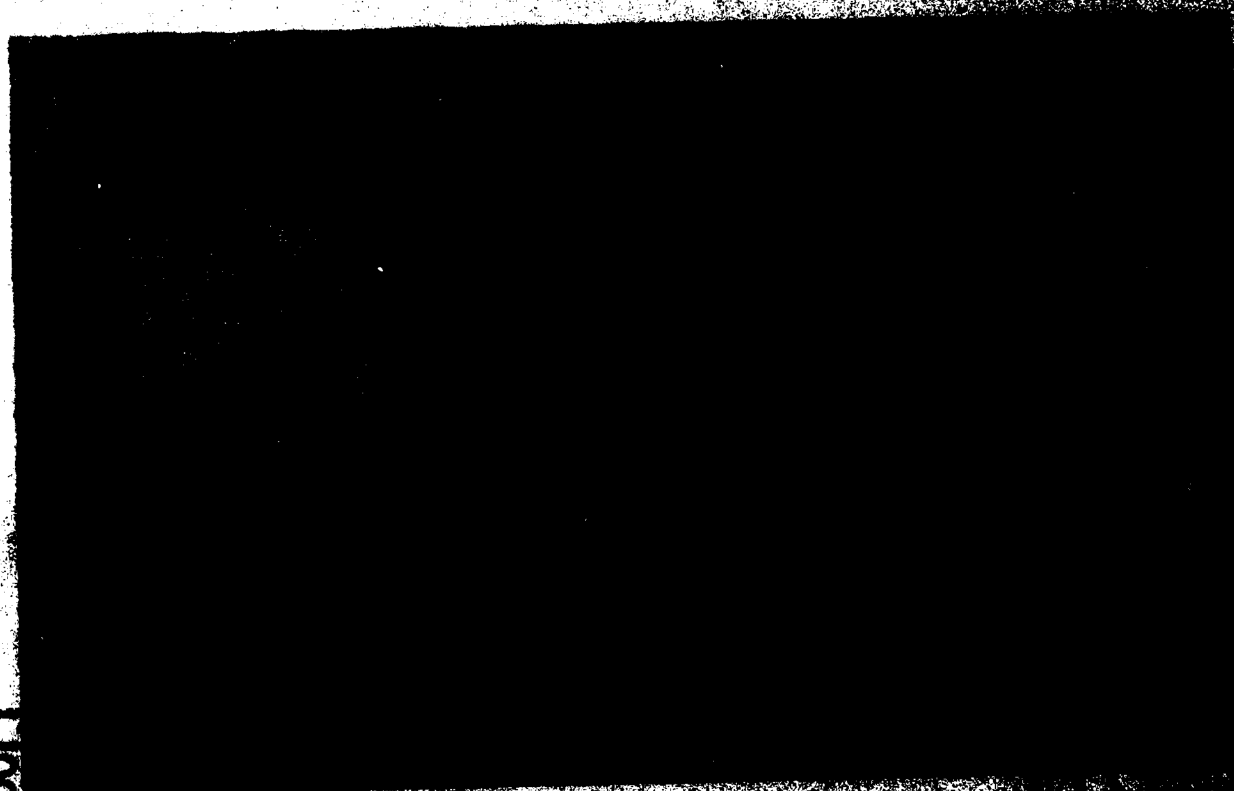
Naval Ocean Research and Development Activity
NSTL Station, Mississippi 39529

Annotated Bibliography of [illegible] Optical Properties of [illegible]



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ABSTRACT

In support of the Defense Mapping Agency, a data base of available marine optical properties from throughout the world has been compiled in this annotated bibliography. This bibliography permits an assessment of amount and type of water optical data available and describes the limitations and problems associated with developing a marine optical data base.

DMA requires temporal coastal atlases of marine optical properties throughout the world. The data listed within the articles of this bibliography provide a reference for assessing atlas development. This data base will also provide ground truth for exploiting alternate technology; namely, remote sensing, to generated marine optics atlases.

From this bibliography, problems associated with establishing a marine optical data base are rapidly seen. Aside from the problem of data being unavailable from numerous ocean/coastal areas where optical measurements have not been made, the types of marine optic properties are numerous and cannot be correlated to form a common data base. Additionally, the temporal variability of marine optics has not been adequately studied and compounds the problem of establishment of a world data base.

ANNOTATED BIBLIOGRAPHY
OF
WATER OPTICAL PROPERTIES
OF
OCEAN WATERS

1. Armstrong, F. A. J. and G. T. Boalch (1961). Ultra-violet Absorption of Sea-water. J. Mar. Biol. Assoc. U.K. (41), 591-597.

Measurements of the ultra-violet absorption spectra between 200 and 400 nm were made with a spectrophotometer. In the deep Atlantic water increased absorption below 235 nm may be due to its high nitrate concentration. A small seasonal effect with increase in absorbancy in summer in the English Channel was seen.

2. Armstrong, F. A. J. and G. T. Boalch (1961). Ultra-violet Absorption of Sea Water. Nature (192), 858-859.

Regional differences of the ultra-violet absorption of sea water were found in the East Atlantic and English Channel, high ultra-violet absorbancies usually being characteristic of coastal waters. Absorbancies at 220 nm were compared with salinities for channel waters.

3. Arnone, Robert A. (1978). Ground Truth Analysis of Multispectral/LASER System Experiment. Naval Coastal Systems Center, Panama City, Florida (NCSC TM 240-78).

In support of a ground truthing experiment, diffuse and volume attenuation coefficients were collected in the coastal waters surrounding Panama City, Florida, and the St. Andrew Bay.

4. Arnone, Robert A. (1977). Water Properties of the Gulf and Bay Waters in Support of ERIM Project, 25-26 May 1977. Naval Coastal Systems Laboratory, Panama City, Florida (Unpublished Report).

Percent transmission with various filters was measured in the Bay and gulf waters off NCSL marina. A limited number of irradiance measurements were made in the gulf.

5. Arnone, Robert A. and Gary G. Salsman (1977). Ground Truth Measurements During April 1976. Tests of ERIM Multi-Spectral Scanning System; Naval Coastal Systems Laboratory, Panama City, Florida, Data Report, July 1977 (Unpublished Report).

Volume attenuation coefficient and diffuse attenuation coefficient values for 14 stations from 1 m to 21 m depths in Panama City Area are presented (portions are published in NCSL R-324-77).

6. Arnone, R. and R. Holyer (1973). NORDA Personal Communication. Water optical data (to be published) collected in the Gulf of Mexico, 1973.

Measurements include spectral K and spectral reflectance of 25 stations characterizing different water masses.

7. Arsen'yev, V. S. and V. I. Voitov (1968). Relative Transparency and Color of Bering Sea Water. (Acad. Sci. USSR) Oceanology (8:1), 41-43 (English trans. Oct. 1968).

Records of the relative transparency and color of sea water were evaluated and used to compile charts of these elements for the Bering Sea in the summer, and for the western part of the sea for the winter. The correlation of relative transparency with the pattern of surface circulation and the displacement of the water masses is shown.

8. Atwell, B. H. (1976). Remote Sensing of Chlorophyll Concentrations, State-of-the-art 1975. NASA Earth Resources Laboratory, Report No. 156.

A summary is given of the present state-of-the-art in remote sensing of chlorophyll. A theoretical approach is outlined and examples from the literature are given on absorption and reflectance of water samples containing chlorophyll, yellow substance and particulate matter.

9. Austin, R. W. and J. H. Taylor (1963). Submarine Visibility and Related Ambient Light Studies. Scripps Institution of Oceanography, Ref. 63-32.

10. Austin, R. W. and J. M. Hood, Jr. (1966). Optical Measurements of Western Pacific Coastal Waters (U). Proc. 3rd U. S. Navy Symposium on Military Oceanography, Vol. 1 (CONFIDENTIAL).

11. Austin, R. W. (1972). Surface Truth Measurements of Optical Properties of the Waters in the Northern Gulf of California. Fourth Annual Earth Resources Program Review, Houston, Texas, January (4), 106-1 through 106-21.

12. Austin, R. W. (1973). Problems in Measuring Turbidity as a Water Quality Parameter. EPA Seminar on Methodology for Monitoring the Marine Environment, Seattle, Washington, October 16-18, 1973.

Transmissometer Profile for Southern California Coastal Waters and Northern Gulf of California. Volume attenuation coefficient for a sample of Cheasapeake Bay water at 400-680 nm.

13. Austin, R. W. (1974). The Remote Sensing of Spectral Radiance from Below the Ocean Surface. Optical Aspects of Oceanography, N. G. Jerlov and E. S. Nielsen (Eds.), Ch. XIV, 317-344.

Includes results of measurements off the coast of Southern California of the upwelling spectral radiance in blue, blue-green and green waters at 350-700 nm wavelengths.

14. Austin, R. W. and T. J. Petzold (1975). An Instrument for the Measurement of Spectral Attenuation Coefficient and Narrow Angle Volume Scattering Function of Ocean Waters. Scripps Institution of Oceanography, Ref. 75-25, September.

15. Austin, R. W. and R. L. Ensminger (1978). A Microprocessor Controlled Instrument for Measuring the Transmittance and Reflectance of Ocean Water. Proceedings of the 22nd Annual Symposium, Ocean Optics V, San Diego, August 1978. Also issued as Scripps Institution of Oceanography, Ref. 78-23, August 1978.

16. Austin, R. W., T. S. Petzold, R. C. Smith, and J. E. Tyler (1980). Handbook of Underwater Optical Measurements. NOAA Contract USDC T 35365.

17. Austin, R. W. (1980). Gulf of Mexico, Ocean-Color Surface Truth Measurements. Boundary-Layer Meteorology (18), 269-285.

In October 1977, a major remote sensing experiment was conducted in the Gulf of Mexico in preparation for the launch of NIMBUS-7, which carried the Coastal Zone Color Scanner. Two major vessels obtained surface-truth measurements, while two jet aircraft at altitudes of 12.5 and 19.5 km obtained images of the surrounding ocean in 10 spectral bands. Measurements obtained in the surface water from the NOAA vessel RESEARCHER of the spectral downwelling irradiances, upwelling radiances, attenutation and scattering properties are described.

18. Austin, R. W. and T. J. Petzold (1980). The Determination of the Diffuse Attenuation Coefficient of Sea Water Using the Coastal Zone Color Scanner. Presented at COSPAR/SCOR/IUCRM Symposium, Oceanography from Space, May 26-30, Venice, Italy.

An algorithm is presented for deriving the diffuse attenuation coefficient (K) of sea water from the ratio of inherent upwelling radiances at 443 and 550 nm. In situ spectroradiometric data from 88 oceanographic stations, taken by U.S., French, and Japanese investigators working in a wide variety of water types, were used to develop empirical relationships between the attenuationn coefficient and the upwelling radiance (or irradiance) ratio. The relationships for estimating K's at 490 nm and 520 nm are presented along with the error of the estimate. Errors in the determination of K from in situ measurements are also discussed.

19. Bailey, James S. and Peter G. White (1969). Remote Sensing of Ocean Color. Advances in Instrumentation, 24 (3) Part III, Paper No. 635, Instrument Society of America. Twenty-fourth Annual Conference Proceedings.

Instruments for quickly and objectively measuring and mapping ocean color variations have been developed and tested. The Wide Range Spectrophotometer (WISP) and the Water Color Spectrometer (WCS) utilize some entirely new concepts conceived and developed at TRW Systems.

20. Baker, R. E. (1970). The Comparison of Oceanic Parameters with Light Attenuation in the Waters Between San Francisco Bay and Monterey Bay, California. M.S. Thesis, Naval Postgraduate School, Monterey, Calif., April, 206 p.

Eighty-six oceanographic stations were occupied in the waters between Monterey Bay and San Francisco Bay. Values of beam transmittance, oxygen content, particulate count, and temperatures were obtained from the surface to 100 meters. The northern part of Monterey Bay had the lowest values of beam transmittance and highest values of particulate count. A fairly good correlation is seen to exist between beam transmittance and particulate count.

21. Bakun, A. (1975). Daily and Weekly Upwelling Indices, West Coast of North America, 1967-73. NOAA Technical Report NMFS SSRF-693, August, 114 p.

22. Ball, T. F. and E. Lafond (1962). Shallow Water Turbidity Studies, Research and Development. Rept. No. NEL-1129, Navy Electronics Laboratory, San Diego, Calif., July, 28 p.

Hydrophotometers were used to measure the light transparency of water near the USNEL Oceanographic Research Tower (Mission Beach) in an attempt to correlate turbidity with time, temperature, and biological aspects.

23. Barham, E. G., J. W. Wilton, and M. P. Sullivan (1966). Plankton and Turbidity. Research and Development. Rept. No. NEL-1386. Navy Electronics Lab., San Diego, Calif., July, 90 p.

An investigation of time and space distribution of microorganisms and other materials producing attenuation of light in the open sea off Mission Beach, California.

24. Barrett, B. B. (1971). Cooperative Gulf of Mexico Estuarine Inventory and Study, Louisiana, Phase II, Hydrology and Phase III, Sedimentology. Louisiana Wildlife and Fisheries Commission, New Orleans, La.

Secchi data collected from 1968-1969 in the Gulf of Mexico off Louisiana.

25. Barrett, B. B., et al. (1978). A Study of Louisiana's Major Estuaries and Adjacent Offshore Waters. Louisiana Department of Wildlife and Fisheries, Tech. Bull. 27, New Orleans, April.

Secchi data collected from 1974 to 1976 in Louisiana waters.

26. Bassett, Charles H. and Harry C. Furminger (1965). An Investigation of the Vertical Variation of Light Scattering in Monterey Bay, California. M.S. Thesis, Naval Postgraduate School, Monterey, Calif., 97 p.

Forty-six water samples were collected at various depths on five separate sampling days at a selected location in Monterey Bay, Calif., and were analyzed for density and inorganic phosphates. Where possible, concurrent light attenuation (horizontal) and solar light extinction measurements were made in situ.

27. Bauer, D. and A. Morel (1967). Etude aux petits angles de l'indicatrice de diffusion de la lumiere par les eaux de mer. Annales de Geophipique (23:1), 109-123.

In situ measurements of the volume scattering function of sea water were carried out. Results from 58 measurements made at different immersions in the Channel and the Mediterranean Sea are shown.

28. Barwick, A. S. (1969). Project Flood Data Report, Caribbean Sea, August 1967 to August 1968. Naval Oceanographic Office, NSTL Station, Miss., Informal Rept. No. NOO-1R-69-52, 34 p.

Oceanographic data collected in the Caribbean Sea in support of Project Flood. Most of the data were collected in the vicinities of Hispaniola, Puerto Rico, and the Virgin Islands. Included are 16 water transparency (Secchi Disc) and color (Forel Scale) observations.

29. Barwick, A. S. (1969). Project Flood Data Report, Tyrrhenian Sea, October 1966. Naval Oceanographic Office, NSTL Station, Miss., Informal Rept. No. NOO-IR-69-18, March, 55 p.

Oceanographic data collected in the Tyrrhenian Sea in support of Project Flood. Includes 10 water transparencies and color observations.

30. Beardsley, G. F., Jr., R. T. Hodgson, J. R. V. Zaneveld, and R. I. Smith (1968). Johnston Island Light Scattering and Transmission Data. Oregon State Univ., Dept. of Oceanography, Data Report No. 31, Project NR 083-102, Ref. 68-6., August, 15 p.

Contains data representing over 3000 individual scattering measurements taken in the equatorial Pacific in the vicinity of Johnston Island. A majority of the measurements are vertical profiles of the volume scattering function accompanying standard hydrographic data of salinty, temperature, and depth.

31. Berryhill, H. L., Jr., et al. (1978). Environmental Studies, South Texas Outer Continental Shelf, 1977, Geology. U. S. Geological Survey Report USGS GD-78012.

Measurements of beam transmission with a Martek transmissometer (528 nm) were taken for 28 stations (surface, middle and bottom) in gulf coastal waters off Texas.

32. Bladh, J. O. (1972). Measurements of Yellow Substance in the Baltic and Neighbouring Seas During 1970-1972, Lysenkil, Sweden, Havsfiskelaboratoriet, Meddelande (138), 15 p.

Yellow substance, a complex mixture of dissolved organic compounds, is expressed as the absorbance coefficient as 380 nm of a filtered sample of seawater. Approximately 100 ml of seawater is vacuum filtered through a membrane filter with a pore size of 0.6 . The absorbance is measured at 380 nm with a spectrophotometer in a 5 cm cell. The yellow substance usually decreases with increasing salinity. In seawater the amount of yellow substance is usually low, while the high values in the Baltic are due to a small exchange with the sea.

33. Blanchard, B. J. and R. W. Leamer (1973). Spectral Reflectance of Water Containing Suspended Sediment. In: Remote Sensing and Water Resources Management, Proceedings of the Symposium, Burlington, Canada, June 11-14, 1973, American Water Resources Association, 339-347.

A spectral radiometer that measures radiation in the visible and near-infrared portion of the spectrum was used to examine (1) different concentrations of red, black, and gray particles in water; and (2) several samples of natural pond water containing sediment. Four of the pond samples had algae present. The samples containing algae showed a good possibility of detecting algae by ratioing the reflectance near 570 nm with that at 680 nm.

34. Boden, B. P., E. M. Kampa, and J. M. Snodgrass (1961). Underwater Daylight Measurements in the Bay of Biscay. J. Marine Biol. Assoc. U.K. (39), 227-238.

Ambient light measurements to depths of 400 m.

35. Boulter, Jacques (1971). Photometric Sous-marine. Measures effectuees pendant la mission Mediprod I. Investigacion Pesquera (35:1), 147-154, January.

Various technical solutions to the problem of measuring and exploring the spectrum underwater are presented with a survey of observations in the northwestern Mediterranean Sea during the cruise Mediprod I. Depth

profiles of downward irradiance and spectral distributions of downward and upward irradiance are shown.

36. Brown, P. J. (1973). Correlation Coefficients Calculated on a World Wide Basis Between Observed Secchi Depths and Other Simultaneously Measured Standard Oceanographic Parameters. M.S. Thesis, U.S. Naval Postgraduate School, Monterey, Calif., 123 p.

37. Burt, Wayne V. (1953). Extinction of Light by Filter Passing Matter in Chesapeake Bay Waters. Science (118:3066), 386-387.

Over one hundred samples were tested for the presence of dissolved colony matter to determine whether colony matter in solution is of importance in the extinction of light in Chesapeake Bay Waters. It was found that the primary factor in light extinction in Chesapeake Bay waters is the particulate matter which can readily be filtered out.

38. Burt, Wayne V. (1955). Interpretation of Spectrophotometer Readings on Chesapeake Bay Waters. J. Marine Res. (14:1), 33-45.

Numerical results of the Mie theory of scattering of light energy by suspended particles have been applied to light extinction measurements obtained from waters of Chesapeake Bay and its major tributaries. A Beckman Model DU Quartz Prism Spectrophotometer with 10 and 50 cm liquid absorption cells was used on raw and filtered samples to determine the extinction as a function of wave length.

39. Burt, W. V. (1958). Selective Transmission of Light in Tropical Pacific Waters. Deep Sea Res. (5), 51-61.

Transmission of light was measured at thirteen wavelengths (400 my - 800 my) on forty-six water samples taken from the eastern tropical part of the Pacific Ocean (Peru Current, southwest of the Galapagos Islands, on the equator, in the counter current, and in the north equatorial current). Samples were taken at fifteen stations at depths ranging from the surface to 1170 m. Measurements of the spectral extinction on filtered and unfiltered samples were made with a Beckman model DU Quartz Prisom Spectrophotometer modified for work at sea. The instrument readings were converted to percent transmission per meter and extinction per meter. The general shape of the transmission curve is shown, along with the relative transparency for a number of samples.

40. Carder, K. L. and K. D. Haddad (1979). Final Report to Bureau of Land Management, Contract AA550-OT7-34, Transmissometry on the Eastern Gulf of Mexico Shelves. MAFLA Outer Continental Shelf Baseline Environmental Survey, 1977-1978, vol. II-B.

Beam attenuation coefficient data collected from 1976 through 1978 in Mississippi, Alabama, and Florida coastal water with a Hydroproducts transmissometer (550 nm).

41. Carder, Kendall L., G. F. Beardsley, Jr., and Hasong Pak (1971). Particle Size Distributions in the Eastern Equatorial Pacific. J. Geophys. Res. (76:21), 5070-5077.

Size distributions for particles larger than 2.22 μ were measured at selected depths in the eastern equatorial Pacific along with the standard hydrographic variables. The volume scattering function at 45° and the particle size distribution as measured at several stations were combined to create an optical vector consisting of the specific light scattering of the average particle and the cross section of the mean particle.

42. Carlson, Quick and Timothy L. McBride (1978). Ocean Visibility Measurements During February and May 1977. Naval Oceanographic Office, NSTL Station, Miss., TN 3005-4-78.

The information presented in this report was obtained from surveys made 600 m west of Gibraltar. Percent transmission through a one-meter path length using ten separate spectral filters and the volume scattering function for three small forward angles was measured by a Scripps transmissometer, ALSCAT. The diffuse attenuation coefficient (K) was obtained for the downwelling light for various depths.

43. Clarke, G. L. (1937-38). Light Penetration in the Caribbean Sea and in the Gulf of Mexico. J. Marine Res. (1:2), 85-94.

Includes results of photometer measurements with green sensitive combination of filters and photoelectric cells taken in the Antilles Current, Northern Equatorial Current, Caribbean Sea, Cayman Sea west of Jamaica, Gulf of Mexico east of the Mississippi Delta, and Sargasso Sea.

44. Clarke, G. L. and Harry R. James (1939). Laboratory Analysis of the Selective Absorption of Light by Sea Water. J. Optical Soc. Am. (29:2), 43-55.

Percentage absorption of light per meter at 3600-8000 A curves for Sargasso Sea, Continental Slope, Continental Shelf, Vineyard Sound and Buzzards Bay, and tables summarizing measurement of penetration of green daylight and comparison with laboratory measurements of absorption of unfiltered samples and comparison of percent absorption per meter of pure sea water with distilled water at 3600-8000 A wavelength is presented.

45. Clarke, G. L. (1941). Observations on Transparency in the Southwestern Section of the North Atlantic Ocean. J. Marine Res. (4:3), 221-230.

Measurements made from the research vessel "Atlantis" on Cruise 14, which extended from Bermuda to the northeast coast of South America and back to New York. An object of the investigation was to learn how closely Secchi Disc determination agreed with the transparency values obtained from the photronic cell photometer.

46. Clarke, G. L. and Charles J. Hubbard (1959). Quantitative Records of the Luminescent Flashing of Oceanic Animals at Great Depths. Limnol. and Oceanog., (4:2) 2 April, 163-180.

Graphical records were obtained of the intensity, duration, and frequency of flashes of luminescent animals at stations in the slope water SE of New York at depths as great as 3750 m.

47. Clarke, George L. (1968). Spectral Change in Light Scattered by the Sea and Its Significance. Progress report 1967. Tech. Paper, 9th Meeting Ad Hoc Spacecraft Oceanography Advisory Group, 23-25 January 1968. Naval Oceanographic Office.

In collaboration with G. C. Ewing and A. C. Conrad, measurements were made of the changes in the intensity and spectral distribution of daylight (sunlight plus skylight) at a series of depths at locations off Woods Hole and off Boston using a radiometer in a water-tight and pressure-resistant case. The energy was recorded on a Sanborn strip chart recorder for each of 25 narrow bands between wavelengths of 360 and 650 mμ. By placing the instrument first in the upright position and then in the inverted position, records were made of the downwelling and upwelling radiation, respectively, for each series of depths at each location.

48. Clarke, G. L. and Gifford C. Ewing (1974). Remote Spectroscope of the Sea for Biological Production Studies. N. G. Jerlov and Steemann Nielsen (eds.), Optical Aspects of Oceanography, Academic Press, London, 389-412.

Spectral measurements of downwelling and upwelling irradiance above and below sea surface at 400-700 nm wavelengths in Buzzards Bay, Mass., Sargasso Sea, Gulf Stream, George's Bank, and George's Shoals.

49. Clark, Dennis K., Edward T. Baker, and Alan E. Stroney (1980). Upwelled Spectral Radiance Distribution in Relation to Particulate Matter in Sea Water. Boundary Layer Meteorology (18), 287-298.

Spectral analysis of water color and concurrent measurements of the relative concentration of various particulate and dissolved constituents within a broad range of water types are necessary to quantify ocean color observations and to successfully relate them to various biological and physical processes that can be monitored by remote sensing. Some of the results of a NIMBUS-G prelaunch cruise in connection with the Coastal Zone Color Scanner (CZCS) experiment, which was carried out in the Gulf of Mexico in October 1977, are presented and discussed.

50. Clark, Dennis (1980). NOAA-NESS, Washington, D.C., Personal Communication.

Water optical data is to be published that was collected in the Gulf of Mexico, western North Atlantic and Gulf of California to Southern California Bight (1200 m). Measurements include spectral upwelling and downwelling irradiance (5 nm increments) from 400 to 750 nm, spectral beam attenuation per meter and Forel-Ule color scale.

51. Crews, Thomas W. (1971). A Study of Light Attenuation in Monterey Bay, California. M.S. Thesis, Naval Postgraduate School, Monterey, Calif., September, 149 p.

A single station was occupied for 27 hours during the upwelling period in Monterey Bay to study light attenuation and its relation to other oceanographic parameters.

52. Davis, P. W. (1965). A Bibliography of Certain Optical Properties of Liquid Water in the Infrared Region (1-2000 microns). Naval Research Laboratory, Applied Optics Branch, Optics Division, Washington, D.C., August, NRL Bibliography No. 25.

A search of the literature has been made for data on the optical properties of water in the infrared region. The purpose of this bibliography is to present a compilation of references containing data concerning

properties such as absorption, reflectance, index of refraction, structure all spectral dependence on temperature and salinity. It was found that there was a serious lack of data pertaining to sea water.

53. DeFalco, Paul Jr., Robert J. Pafford, Jr., and John R. Teerink (1971). The Effects of Agricultural Waste Water Treatment on Algal Bioassay Response. Environmental Protection Agency, San Francisco, Calif. Region IX., 57 p.

After experimentally subjecting agricultural waste water to two different nitrogen removal processes, it was added in various percentages to the San Joaquin River Delta. The algal growth throughout time was monitored by chlorophyll fluorescence techniques. The results showed logarithmic growth. The laboratory experiments gave positive statistical evidence that the untreated agricultural waste water would promote substantial algal growth above that of the San Joaquin River controls.

54. Dera, Jerry and Howard R. Gordon (1968). Light Field Fluct ions in the Photic Zone. Limnol. and Oceanog. (13), 697-699.

Measurements were carried out in the coastal waters of uth Florida and in the shallow Bahama Banks of the light field fluctua s using an underwater irradiance meter with a Selenium photocell, nm filter having a 50 nm passband and a fast recorder.

55. Doerffer, Roland (1980). Applications of a Two-flow Model for Remote Sensing of Substances in Water. Boundary Layer Meteorology, (18) 221-232.

The linear relationship between the attenuation coefficient, K and the concentration of suspended matter is shown for water samples taken from streams along a 200 km profile in the Elbe River Estuary and the North Sea.

56. Duursma, E. K. (1974). The Fluorescence of Dissolved Organic Matter in the Sea. In: Optical Aspects of Oceanography, N. G. Jerlov and E. Steeman Nielson (eds.), Academic Press, 237-256.

This review article is concerned with the methodology of measuring fluorescence of dissolved organic matter in the sea. Few organic compounds are discussed. Fluorescence plots as a function of wavelength are given for water samples from Mauritania, Mediterranean, Villefranchsur-mer, Nice (France), and distilled water. Results from experiments and in situ investigations (Irminger Sea between Greenland and Scotland) are also given.

57. Egan, W. G. (1974). Measurement of the Fluorescence of Gulf Stream Water with Submerged In Situ Sensors. J. Marine Technol. Soc. (8:10), 40-47.

Fluorescence measurements were conducted along the Gulf Stream approximately between 30°N, 80°W and 39°N, 62°W during the period July 14 to August 13, 1969. Seawater was irradiated with long and short wavelength ultraviolet radiation to produce red fluorescence in phaeo and chloroplastic pigments and broadband fluorescence in Gelbstoff and dissolved minerals. It was found that higher red fluorescence values tend to be in locations where Gelbstoff and/or mineral fluorescence are greater.

58. El-Sayed, S. Z. (1974). Unpublished data of Texas A&M University Cruises 71-A-6, 72-A-12, and 73-A-12.

Secchi data collected in Gulf of Mexico from 1971 through 1973.

59. Emery, K. O. (1954). Transparency of Water Off Southern California. Trans. Am. Geophys. Union (35), 214-220.

Secchi disc readings off Southern California show a close relationship between water transparency and detrital and, organic sediment along the mainland and island shores, and to organic production in a large area of upwelling near the central slope.

60. Environmental Research Institute of Michigan (1972). October 2-6 Proceedings of the 6th International Symposium of Remote Sensing of Environment, 617-637.

The technique of measuring water depths with an airborne pulsed dye laser is studied, with emphasis on the degrading effect of some environmental and operational parameters on the transmitted and reflected laser signals. Extrapolation of measurements of laser-stimulated fluorescence, performed as a function of both the algal cell concentration and the distance between the algae and the laser/receiver, indicates that a laser system operating from a height of 500 m should be capable of detecting chlorophyll concentrations as low as 1-0 mg/m^3.

61. Environmental Planning Study (Strategic Straits)(U)(1947-1980). Informal Reports, CR Special Publications, Naval Oceanographic Office, NSTL Station, Miss., (CONFIDENTIAL to SECRET).

Water transparency data measured by Secchi disc in various strategic straits, in chapter 8.

62. Environmental Protection Agency, STORET Data Base.

Secchi data collection from 1966 to 1979. Three thousand observations for selected stations off Florida. Stored on magnetic tape.

63. Ewing, G. C. (1973). Remote Sensing of Ocean Color as an Index of Biological and Sedimentary Activity. Cospar, Plenary Meeting, 16th, Konstanz, West Germany.

Over 3000 ocean spectra of sunlight backscattered from the upper layers of the sea have been obtained at flight altitudes of up to 10,000 feet together with detailed ground truth. The spectra reveal the action of the water. The relationship between light extinction and biological productivity has been studied. Certain important materials have recognizable spectral signatures; thus the shapes of the spectra can be used for identification and quantification of substances present.

64. Ewing, G. C. (1965). Oceanography from Space. Woods Hole Oceanographic Institute, Ref. No. 65-10.

Observations of transparency and luminescence flashing have been made off the NE coast of U.S., across the continental shelf into the deep water and the Gulf Stream, as well as on George's Bank and the deep basin of the

Gulf of Maine. In addition, observations have been made off Greenland, the Caribbean and Mediterranean Seas, and the Western Indian Ocean. Luminescence flashings have been reported in the Pacific off the coast of California and the Hawaiian Islands.

65. Faller, K. H. (1974). Sea Remote Sensing Program, Remote Sensing of Oceanic Parameters During the Skylab/Gamefish Experiment. NASA Earth Resources Laboratory, Report No. 119.

Aircraft and surface data related to Skylab experiment 240 were obtained over an area in the Gulf of Mexico located southwest of Destin, Florida. Data of interest were surface temperature, chlorophyll concentration, and Secchi extinction depth. Differences in remote and surface data of temperature, chlorophyll, and turbidity are discussed.

66. Fleischer, P., D. E. Bowker, W. G. Witte, T. A. Gosink, W. J. Hanna, and J. C. Ludwick (1976). Correlation of Chlorophyll, Suspended Matter, and Related Parameters of Water in Lower Chesapeake Bay Area to LANDSAT-1 Imagery. Old Dominion University Research Foundation, Norfolk, Virginia (NAS5-21816).

Water parameters of the lower Chesapeake Bay area have been correlated to multispectral-scanner images of LANDSAT-1, thereby demonstrating the feasibility of synoptic mapping of estuaries by satellite. Water data were collected for one year at the time of LANDSAT-1 overpasses. Bands 5 and 6 of the MSS were shown to be useful for monitoring total particles, while band 5 showed high correlation with suspended sediment concentration. Attenuation coefficients monitored continuously by ship along three baselines were cross-correlated with radiance values on three days. A contouring program was developed to display sediment variation in the lower Chesapeake Bay from the MSS bands.

67. Flemer, D. A. (1969). Continuous Measurements of In Vivo Chlorophyll of a Dinoflagellate Bloom in Chesapeake Bay. Chesapeake Science (10:2), 99-103.

The fluorometric method was used to obtain a continuous in vivo record of chlorophyll a distribution in surface waters of the mid-Chesapeake Bay. Measurements were made just previous to and during a full dinoflagellate bloom. Chlorophyll a values computed from calibration curves ranged from 10 to 56 mg/m^3. The effect of the temperature range encountered on the accuracy of the data is discussed. Values as high as 167 mg/m^3 were found during the bloom. The relationship between chlorophyll a and fluorescence was significant for both the dinoflagellate and nonflagellate data.

68. Fonds, J. and D. Eisma (1967). Upwelling Water as a Possible Cause of Red Plankton Bloom Along the Dutch Coast. Netherlands J. Sea Res. (3:3), 458-463.

Investigations were made for the cause of the red plankton bloom in the sea off Egmond, along the Dutch coast. Determinations were made of salinity and content of suspended matter at various depths along a traverse at right angles to the coast. These results revealed that the persistent blowing of coastal winds during the previous days caused a circulation to develop that had a shoreward movement along the bottom and a seaward movement at the surface. This movement caused the coastal water

of lower salinity and higher content of suspended matter to be displaced in a seaward direction. Between this displaced coastal water and the coast itself, where the bloom occurred, water was found that had a higher salinity and a lower content of suspended matter.

69. Foster, P., G. Savidge, G. M. Foster, D. T. E. Hunt, and K. B. Pugh (1976). Multivariate Analysis of Surface Water Characteristics in the Summer Regime of the Western Irish Sea. J. Exp. Mar. Biol. Ecol. (25), 171-185.

During summer, a seasonal thermocline is formed in the Western Irish Sea. A strong horizontal thermal gradient is associated with this front. During July 1974 data were collected on salinity, temperature, transparency, chlorophyll a, nitrite, nitrate, silicate and phosphate across and along the front which separates the stratified surface water regions of the western Irish Sea from the mixed surface zones.

70. Frederick, Margaret A. (1970). An Atlas of Secchi Disc Transparency Measurements and Forel-Ule Color Codes for the Oceans of the World. M. S. Thesis, Naval Postgraduate School, Monterey, Calif., 188 p.

An investigation was made of the global distribution of Secchi disc water transparency measurements and Forel-Ule water color codes that were on file at the National Oceanographic Data Center prior to June 1969. Charts were constructed for seventeen major areas of the world's oceans to show the horizontal distributions of transparency and water color. Data were generally presented as mean distributions.

71. Fry, E., Texas A&M College Station, Personal Communication.

Has polarizing light scattering data (Mueller matrix) for east coast of U. S.; to be published.

72. Gall, M. H. W. (1949). Measurements to Determine Extinction Coefficients and Temperature Gradients in the North Sea and English Channel. J. Marine Biol. Assoc., U. K., 28:757-780.

73. Gilbert, G. D. and R. O. Rue (1967). Light Attenuation Measurements Off the Coast of Baja California. Naval Ordnance Test Station, China Lake, Calif., Tech. Pub. NOTS-T-4343, 70 p.

In a continuation of deep sea light attenuation studies, the Null-Balance transmissometer (NBT) and the Janus irradiance meter, both developed by the visibility lab of the Scripps Inst. of Oceanography for NOTS were used to measure the volume attenuation coefficient of light and ambient light in the waters off the coast of Baja California. This report discusses best procedures and data obtained in 22 tests conducted at 22 stations near lower California.

74. Gilbert, Gary (1968). Underwater Light Attenuation Data Taken Near San Clemente Island. Naval Weapons Center, China Lake, Calif., Rept. No. NWC-TP-4542, April, 26 p.

The volume light attenuation coefficient of the water of the California channel near San Clemente Island was measured. The attenuation structure of this water is a surface attenuation layer approximately 50 meters

thick which changes abruptly to a uniformly clear mass of water that extends to the maximum lowering depth of the null-balance transmissometer or the floor of the ocean, whichever occurs first.

75. Gilbert, Gary D. (1965). Deep Sea Light Attenuation Measurements at 2,000 Meter Depths. Naval Ordnance Test Station, China Lake, Calif., Rept. No. NOTS-TP-3994, Dec., 24 p.

The first deep sea tests of the null-balance transmissometer in which measurements were made to the 2,000 meter maximum depth capability of the instrument are documented in this report. The tests were conducted at ten locations in the North Pacific from the Aleutian Islands to the Island of Oahu in the Hawaiian archipelago.

76. Godcharles, M. F. and W. C. Jaap (1973). Fauna and Flora in Hydraulic Clam Dredge Collections from Florida West and Southeast Coasts. Special Scientific Report No. 40, Florida Department of Natural Resources Marine Research Laboratory.

Secchi data collected in Florida coastal waters from 1970-71.

77. Gordon, H. R. and J. Dera (1969). Irradiance Attenuation Measurements in Sea Water Off Southeast Florida. Bull. Mar. Science (19:2), 279-285.

The irradiance attenuation coefficent at 525 nm was measured in Biscayne Bay, the Florida Straits, the NW Providence Channel, and the Little Bahama Bank.

78. Gordon, H. R. and A. W. Wonters (1978). Some Relationships Between Secchi Depth and Inherent Optical Properties of Natural Waters. Appl. Opt. (17:21), 3341-3343.

79. Gordon, Howard R. and Dennis K. Clark (1980). Atmospheric Effects in the Remote Sensing of Phytoplankton Pigments. Boundary Layer Meteorology (18:3), 299-313.

Experimental data for this investigation were acquired off the coast of Southern California, in Chesapeake Bay at Mill Creek, Md., and at various locations throughout the Gulf of Mexico, including the Mississippi River discharge region. The data used are the concentration of chlorophyll a plus phaeophytin a measured with a Turner III flourometer. Submersible scanning spectroradiometers constructed by NESS and Gamma Scientific, Inc., were used to measure the upwelled spectral radiance at 440, 520, and 550 nm.

80. Gower, J. F. R. (1980). Observations of In Situ Fluorescence of Chlorophyll-a in Saanich Inlet. Boundary Layer Meteorology (18), 235-245.

The possibility of using the in situ flourescence line of chlorophyll-a in remote sensing studies of surface water productivity is investigated in a series of spectroscopic and water sampling measurements made from a launch in Saanich Inlet, British Columbia, Canada.

81. Grady, J. R. (1979). Secchi Measurements Off Louisiana and Texas Collected During Five Cruises of the GAS III, January to May 1965. National Marines Fisheries Service, Panama City, Florida.

82. Graham, J. J. (1970). Secchi Disc Observations and Extinction Coefficients in the Central and Eastern North Pacific Ocean. Limnol. and Oceanog. (5:5), 688-694.

Measurements of submarine daylight were made with a photometer and Secchi disc and of water color with a Forel-Ule color scale during three summer cruises in the central and eastern North Pacific Ocean. The relationships between extinction coefficients, reciprocals of Secchi disc readings, and color observations were determined and their applications and limitations are discussed.

83. Grew, Gary W. (1976). Remote Detection of Chlorophyll a in Coastal Waters. Fifth Annual Remote Sensing of Earth Resources Conference, Tullahoma, Tenn., (March 29-31).

An algorithm for the remote detection and quantification of chlorophyll a in coastal zone waters has been established for concentrations above 15 µg/ℓ. Multichannel Ocean Color Sensor (MOCS) data collected in the New York Bight in April 1975 as part of a NASA-NOAA Remote Sensing Program are compared with data collected during an EPA-sponsored mission in Hampton Roads, Virginia, in May 1974. Spectral signatures of algae, sediment, and acid waste are presented.

84. Grindley, J. R. and F. J. R. Taylor (1970). Factors Affecting Plankton Blooms in False Bay. Trans. Roy. Soc. South Africa (39:2), 201-210.

Organisms causing plankton blooms which produced visible discoloration of the sea in False Bay are recorded. The factors that may cause the blooms to develop are temperature, wind, light intensity and upwelling. Local upwelling of nutrient-rich water occurs in the northeastern sector of the Bay. A computer study of the local wind-induced upwelling at Gordon's Bay indicated that there was a high correlation between wind velocity and degree of upwelling as indicated by water temperature.

85. Gross, E. L. and S. H. Prasher (1974). Correlation Between Monovalent Cation-induced Decreases in Chlorophyll a Fluorescence and Chloroplast Structural Changes. Archives Biochem and Biophys. (164), 460-468.

Low concentration (≃3 mM) of salts of monovalent cations were found to decrease the turbidity of the chloroplast suspensions. The turbidity changes have the same kinetics salt concentration and pH dependence as the monovalent cation-induced decreases in chlorophyll a fluorescence. Structural changes are suggested as a cause.

86. Halldal, Per (1974). Light and Photosynthesis of Different Marine Algal Groups. Optical Aspects of Oceanography, N. Q. Jerlov and E. Steemann Nielsen (Eds.), Academia Press, 345-360.

Measurements made with the prototype for the Incentive Research and Development Quanta spectrometer, QSM 2400, in connection with marine algal photosynthesis. Locations are Gullmarstjorden (at the west coast of Sweden) and Kings Bay (Spitsbergen).

87. Heavers, R. M. (1967). Measurements of Underwater Reflectance and Attenuation of Diffuse Light near Kamchatka, U.S.S.R., During August-September 1966. Naval Oceanographic Office, Washington, D.C., Informal Report No. IR-67-65, 21 p.

Measurements of underwater reflectance and of the attenuation coefficient for diffuse light were made as part of an oceanographic survey aboard USS FLORIKAN (ASR-9) off the coast of Kamchatka, U.S.S.R., during August-September 1966.

88. Heathershaw, D. C. and J. H. Simpson (1974). Fine Structure of Light Attenuation and Its Relation to Temperature in the Irish Sea. Estuarine and Coastal Marine Science (2), 91-103.

Detailed observations of optical beam transmittance have been made in a stratified region of the Irish Sea. The variations in optical transmittance are found to be strongly influenced by the temperature structure, significant gradients of both parameters frequently occurring together. Strong minima in transmittance with a horizontal length scale of kilometers have been observed in the thermocline. A steady state vertical diffusion model is applied to the data below the thermocline.

89. Hemmings, C. C. (1965). Factors Influencing the Visibility of Objects Underwater. In: Light as an Ecological Factor, R. Bainbridge, G. C. Evans, and O. Rackham (Eds.), John Wiley and Sons, Inc., New York, 359-374.

Results of work in Malta and the Moray Firth.

90. Hickel, W., E. Hagmeier, and G. Drebes (1971). *Gymnodinium* Blooms in the Helgoland Bight (North Sea) during August, 1968. Helgolander wiss. Meeresunters (22), 401-416.

Red tides occurred in Helgoland waters in August 1968. Planktological and hydrographical investigations were made at three areas south, southwest, and northwest of Helgoland as well as at two drifting stations off the mouths of the Elbe and Eider rivers. A marked vertical stratification of *Gymnodinium* with a concentration toward the surface during the day was observed, particularly in the turbid water of the Elbe estuary. The chlorophyll *a* content of one million *Gymnodinium* was only 3-5 g. Blooms developed in the coastally influenced water masses east of Helgoland. The red tides occurred during a period of minimal discharge of Elbe River water and of relatively high salinity of the coastal water.

91. Hickman, G. D. (1979). Fluorescence and Ocean Color of the World's Oceans Annotated Bibliography. Applied Science Technology, Inc., Rept. No. AST-R-040979, 1011 Arlington Blvd., Arlington, Va. 22209.

An extensive literature search (covering the period 1950 - 1978) was performed dealing with research and reports concerned with the bioluminescence, fluorescence and ocean color of the world's oceans. This volume contains only the abstracts on fluorescence and ocean color. The bioluminescence abstracts were previously released as an Applied Science Technology (AST-R-030879 - August 1979) publication. The majority of the abstracts making up this bibliography can be catalogued into one or more of the following categories: *in situ* measurements, basic laboratory measurements, remote sensing measurements, and new instrumentation design. Additionally, a large number of the abstracts are concerned with one or more of the following subject areas: Chlorophyll, Red tides and Gelbstoff.

92. Hishida, Kozo (1966). On the Scattering and the Attenuation of Light in Sea Water. J. Oceanog. Soc. Japan (22:1), 1-6.

The scattered light in the directions of 45°, 90° and 135° and the attenuated light were measured in the laboratory for sea water samples taken in and off Maizuru Bay in the Japan Sea.

93. Hojerslev, N. K. (1980). Water Color and Its Relation to Primary Production. Boundary Layer Meteorology (18), 203-220.

It is shown both experimentally and theoretically that the depth of the euphotic zone is related to the color of the sea defined as a color index equal to the ratio of the upwelling blue (450 nm) and green (525 nm) nadir daylight just below the sea surface. Some of the data used in this report is from: Hojerslev, 1974 (Fig. 1, Distribution of the Attenuation coefficient in a vertical section in the Baltic Sea), Hojerslev, 1978 (Fig. 3, color index and depths of selected quanta percentage levels vs. time at Fladen Ground in the North Sea), Hojerslev, 1978 (Fig. 5, Depths of percentage levels for the downward irradiance 350-700 nm vs. time at Fladen Ground in the North Sea).

94. Hojerslev, N. K. (1973). Inherent and Apparent Optical Properties of the Western Mediterranean and the Hardanger Fjord. Univ. Copenhagen Inst. Phys. Oceanogr. Rep. (11), 18.

95. Hojerslev, N. K. (1974). Inherent and Apparent Optical Properties of the Baltic. Rep. Inst. Phys. Oceanogr., Univ. of Copenhagen (23), 70.

96. Hojerslev, N. K. and B. Lundgren (1977). Inherent and Apparent Optical Properties of Icelandic Waters. Sjarni Saemun Jsson Overflow 73, Rep. Inst. Phys. Oceanogr., Univ. of Copenhagen (33), 63.

97. Hojerslev, N. K. (1978). Inherent and Apparent Optical properties of the North Sea. Fladen Ground Experiment-FLEX 75, Rep. Inst. Phys. Oceanogr., Univ. of Copenhagen (32), 34.

98. Holmes, R. W. (1970). The Secchi Disk in Turbid Coastal Waters. Limnol. and Oceanog. (15:5), 688-694.

Measurements of Secchi disk depth are correlated with beam tranmittance (B) in turbid coastal water. Both k (the irradiance attenuation coefficient) and alpha (the beam attenuation coefficient) can be estimated from the Secchi depth either on an empirical basis or by using the Duntley-Preisentorfer equation of contrast reduction. Optical instruments used to obtain measurements in Goleta Bay, east of the Univ. of Calif. campus at Santa Barbara were a relative irradiance meter and a 1-meter path length beam transmittance meter, both filtered to yield a photopic response (Weston barrier layer cells with Wratten 2 filters). Table 2 is a summary of optical data obtained in Goleta Bay on seven separate days.

99. Hornig, A. W. and D. Eastwood (1973). A Study of Marine Luminescence Signatures, Part 1, NASA-CR-114578.

Fluorescent excitation and emission spectral data on chlorophyll and Gelbstoff in natural sea waters from the Atlantic, Gulf and Pacific coasts

show that algal particulates are totally absorbing over much of the near ultraviolet and visible spectra and act approximately as quantum counters; plant pigments absorb energy and transfer a large portion to chlorophyll fluorescence. It is concluded that luminescence data of natural sea waters are useful in monitoring algal and Gelbstoff as well as pollutant concentrations.

100. Hughes, R. S. and R. W. Austin (1965). Deep-Sea Light Attenuation Measurements with a Null-Balance Transmissometer. U. S. Naval Ordnance Test Station Report, TP3748.

This report, which discusses an investigation into the volume attenuation coefficient of light in the sea, also describes a newly developed null-balance transmissometer capable of measuring this coefficient of light to a depth of 2000 m. Data obtained to a depth of 700 m are presented. These data cover that portion of the spectrum from 4980 A° to 5800 A°. (The tests were conducted one mile from San Clemente Island.)

101. Hurlbert, E. O. (1945). Optics of Distilled and Natural Water. J. Opt. Soc. Am.(35:11), 698-700.

Laboratory measurements of the absorption and scattering of visible light in distilled water, Chesapeake Bay and Atlantic ocean water.

102. International Commission for the Northwest Atlantic Fisheries (1968). Environmental Surveys, NORWESTLANT 1-3, 1963. Part III. Oceanographic Data Record. Volume I. NORWESTLANT 1. 2:(410) NORWESTLANT 2., 464 p. Special Publ. No. 7 of the ICNAF prepared by Canadian Oceanographic Data Centre, Ottawa.

Secchi disk data for the following regions: Irminger Sea, West Greenland Waters, Atlantic Ocean, and Davis Strait.

103. Isaacs, John D., Sargun O. Tont, and Gerald L. Wick (1974). Deep Scattering Layers: Vertical Migration of a Tactic for Finding Food. Deep Sea Research (21), 651-656. California Current Region.

Irradiances at deep scattering layer depths calculated from upwellng spectral irradiance data obtained at 480 nm by Smith (1973) using Scripps spectroradiometer during SCOR DISCOVERER expedition.

104. Ivanoff, Alexandre, Nilo Jerlov, and Talbot H. Waterman (1961). A Comparative Study of Irradiance, Beam Transmittance and Scattering in the Sea near Bermuda. Limnol. and Oceanog. (6), 129-148.

Comparative measurements of a number of optical properties of the sea were made at 6 stations and at depths down to 245 m near Bermuda. In situ determinations included attenuation of natural radiant energy and reflectance between 375 and 651 m, beam transmittance and scattering, as well as polarization 90° to the beam. In the laboratory, scattering and degree of polarization were determined at 90° from water samples, while scattering was also measured at 45° to the beam. Both photovoltaic cells and photomultipliers were used as required.

105. Jacobs, M. B. and M. Ewing (1969). Suspended Particulate Matter: Concentration in the Major Oceans, Science (163), 380-383.

Quantitative data from over 500 concentrates of suspended particulate material has been summarized statistically for the Atlantic, Pacific and Indian Oceans, the Gulf of Mexico, and the Caribbean Sea.

106. Jarrett, O., Jr., P. B. Mumola, and C. A. Brown, Jr. (1973). Four Wavelength Lidar Applied to Determination of Chlorophyll a Concentration and Algae Color Group. In: Remote Sensing and Water Resources Management; Proceedings of Symposium, Burlington, Ontario, Canada, June 11-14, 1973, American Water Resources Association, p. 259-268.

A technique for remote measurement of chlorophyll a density of algae colcr (green, golden-brown, red and blue-green) are described and representative spectra shown. The lidar equation is developed for the general case of a mixture of color groups showing the need for multi-color excitation. The lidar instrument was designed and fabricated at Langley Research Center for helicopter flights over various areas of the Chesapeake Bay. It permits multicolor excitation of chlorophyll a fluorescence from the various color groups of algae by the use of a four-color dye laser.

107. Jerlov, N. G. and B. Kullenberg (1953). The Tyndall Effect of Uniform Minerogenic Suspensions. Tellus (5), 306-307.

The distribution of matter suspended in ocean water was studied during the Swedish Deep-Sea Expedition by measuring the Tyndall effect in water samples (Jerlov, 1953). The scattering, s km^{-1}, caused by particles in suspension was computed.

108. Jerlov, N. G. (1953). Influence of Suspended and Dissolved Matter on the Transparency of Sea Water. Tellus (5), 59-65.

The transparency at different levels in the sea as recorded by means of a transparency-meter is compared with the distribution of suspended particles studied with the aid of a Tyndall-meter. A simple procedure is used to distinguish between different components of light extinction and to drive values of the content of the dissolved yellow substance. The distribution of yellow substance is illustrated for the transition area between the Baltic and Skagerrak and for the outflow of the Göta Alv. It is emphasized that the content of yellow substance may often be considered as a characteristic property on a water mass.

109. Jerlov, N. G. (1955). Factors Influencing the Transparency of the Baltic Waters. Medd. Oceanogr. Inst. Golebary (25), 19 p.

Distribution of particles and of yellow substance were studied by optical means during two summer cruises in the Baltic Sea. Special regard was paid to conditions in the Sandsvall Bight to which large amounts of river water are supplied.

110. Jerlov, N. G. (1958). Distribution of Suspended Material in the Adriatic Sea. Arch. Oceanogr. Liminol. (11), 227-250.

The distribution of particulate material in the Adriatic Sea was studied by means of a Tyndall-meter on water samples collected during the Italian-Swedish expedition in August 1955.

111. Jerlov, N. G. and Jacques Piccard (1959). Bathyscaph Measurement of Daylight Penetration into the Mediterranean. Deep Sea Research (5:3), 201-204, March.

The penetration of blue daylight down to 300 m was measured during dives with the bathyscaph TRIESTE south of Capri. The results show the gradual increase in daylight extinction from the surface to 100 m which is typical for clear water.

112. Jerlov, N. G. and M. Fukuda (1960). Radiance Distribution in the Upper Layers of the Sea. Tellus (12), 348-355.

The angular distribution of underwater radiance for green light has been studied in the upper turbid layers of the Gullmar Fjord by means of a radiance meter which is lowered in the sea along a guide wire with a fixed orientation. A theoretical discussion considers the different components entering into the light field, viz. direct sunlight, skylight, and scattered light.

113. Jerlov, N. G. (1961). Optical Measurements in the Eastern North Atlantic (Discovery II Expedition, August and Sept. 1959) Yale Univ., New Haven, Conn., Contract No. NR6.0923.

The optical work included measurements of the penetration of radiant energy from the sun and sky extended to as great depths as possible with the equipment. A great deal of interest was focused on the distribution of particles which produce underwater light scattering. The volume scattering function was also recorded.

114. Jerlov, Nilo G. (1961). Optical Classification of Ocean Water in Physical Aspects of Light in the Sea: A Symposium. John E. Tyler (ed.), Univ. of Hawaii Press, p. 45-49.

Contains volume scattering function curves representing the mean value of measurements for blue light (465 nm) in the eastern North Atlantic.

115. Jerlov, N. G. (ed.) (1961). Union Geodesique et Geophysique International Monographic No. 10. A publication of the papers given at the Symposium on Radiant Energy in the Sea, Helsinki, August 4-5, 1960. Available from I.U.G.G. Publications Office, 39 ter Rue Gay - LUSSAC 76, Paris V, France.

Contains papers on theory, experiment and instrumentation with some applications to biological process and descriptive oceanography.

116. Jerlov, N. G. (1961). Optical Measurements in the Eastern North Atlantic, Medd. Oceanogr. Inst. Goteborg, Ser. B (8), 40 p.

The volume scattering function was recorded by means of a new in situ scattering meter used in the water area between Madeira and the Iberian and African coasts. Irradiance data prove that the surface state of the investigated waters are intermediate between Type I and Type II of the Jerlov classification.

117. Jerlov, N. G. and K. Nygard (1968). Inherent Optical Properties Compiled from Radiance Measurements in the Baltic. Kobenhavens Universitet Institut for Fysisk Oceanografi, Report No. 1, Copenhagen.

118. Jerlov, N. G. and E. Steeman Nielsen (eds.) (1974). Optical Aspects of Oceanography. Academic Press, London, 494 p.

Collected papers presented at the Symposium on Optical Aspects of Oceanography held at the Institute of Physical Oceanography, Copenhagen, Denmark, June 19-23, 1972. Included in this bibliography are papers which contain water optical data from a large majority of the world oceans.

119. Jerlov, N. G. (1974). Significant Relationships Between Optical Properties of the Sea. In: Optical Aspects of Oceanography, Jerlov and Nielsen (eds.) chapt. 4, 77-94.

Attenuation coefficient (per meter) for red (655 m) and ultraviolet (380 m) portion of the spectrum are referenced. Locations are Continental Slope (Atlantic), Peru Coastal Waters, Bermuda Waters, Caribbean Sea, Baltic Sea, Sargasso Sea and Mediterranean Sea.

120. Jerlov, N. G. (1976). Marine Optics. Elsevier Oceanography Series 14, Elsevier Scientific Publishing Company, Amsterdam, 226 p.

Excellent book on the basics of water optics. Various chapters contain examples of water optical properties from all over the world oceans.

121. Johnson, Robert W. (1978). Mapping of Chlorophyll-a Distributions in Coastal Zones. Photogrammetric Engineering and Remote Sensing (44:5), May, 617-624.

Results of experiments with aircraft multispectral scanners over the James River, Virginia, and the New York Bight ocean area indicate that statistically significant quantitative relationships exist between remotely sensed data and chlorophyll-a sea-truth measurement.

122. Jones, D. and M. S. Wills (1956). The Attenuation of Light in Sea and Estuarine Waters in relation to Concentrations of Suspended Solid Matter. J. Marine Biol. Assoc. U.K., (35), 431-444.

Attenuation coefficient measured in situ for sea and esturine waters near Plymouth and in the Thames Estuary. The Secchi disk visibility was inversely proportional to the attenuation coefficient over the range 1.5 to 21 meters.

123. Joseph, Joachim (1950). Durchsichtigkeitsregistrierungen als ozeanographische Unterschungsmethode. (Transparency records as a method of oceanographical investigation.) (In German.) Sonderdruck aus der Deutschen Hydrographischen Zeitschrift (3:1/2), 69-77.

By currently recording the measuring values of a transparency meter in various regions of the spectrum not only a survey of the turbidity is obtained but also far-reaching conclusions concerning the hydrographic structure and their dynamic agitation are rendered possible. After a description of the measuring method, as an example an "optical section" through the Kattegat, which was obtained during a cruise on board "Paul Beneke" in autumn 1949, is discussed.

124. Joseph, Joachim (1950). Untersuchungen Über ober und Unterlichtmessurngen (im Meere und Über ihren Zusammenhang) mit Durchsichtig Keitsmessunge Deutsches Hydrographischen Zeitschrift (3), 324-335.

Investigations into the measurements of the downward and upward components of submarine illumination and their relation to transparency measurements. Formulae and diagrams for the determination of these optical constants of sea water are given and a laboratory experiment as well as a series of measurements from the western Baltic are discussed.

125. Joseph, Joachim (1953). Die Trubungsvertaltnisse in der sudwestlichen Nordsee wahrend der "Gauss"-Fahrt in Feb. Ber. Deutsch. Wiss. Komm fur Meeresforschung (13:2), 93-103.

Turbidity and extinction measurements in the southwestern North Sea. The turbidity was registered over 2100 miles by a measuring instrument attached to the keel of the "Gauss".

126. Joseph, Joachim (1959). Die Trubungsverhaltnisse in der Irminger Sea im June 1955 und ihre hydrographischen Ursachen. Ber. Dtsch. Wiss. Komm. Meerseforsch (15:3), 238-259.

Description of horizontal and vertical measurements of turbidity carried out by FFS. Anton Dohen in the waters between Iceland and Greenland (East Greenland current and Irminger Sea) in June 1955.

127. Joseph, Joachim (1959). Uber die vertikalen Temperature und Trubungsregistrierungen in einer 500 m machtigen Deckschicht des nordlichen norditlentschen Ozeans. Deut. Hydrograph Z. (3), 48.

Results of continuous temperature and turbidity measurements from the surface down to a depth of 500 m at 243 stations in the North Atlantic Ocean are discussed and illustrated.

128. Joseph, Joachim (1961). Trubungs. und Temperatur Verteilung auf den Stationen und Schnitten von V.F.S. "Gauss", 1957-1958. Dent. Hydrograph. Z (5).

Fourteen vertical sections represent the results of measurements of temperature and turbidity obtained on board the V.F.S. "Gauss" at 241 stations in the North Atlantic Ocean in March/April and August/September 1958.

129. Joyce, E. A. and J. Williams (1969). Memoirs of the Hourglass Cruises, Vol. I, Part I. Florida Department of Natural Resources, 50 p.

Secchi data collected from 1966-1969 in Florida waters.

130. Kadishevich, E. A., Yu. S. Lyubovkeva, and V. M. Pavlov (1974). Optical Investigations in the Deep Water Tonga Trench. In: Monin and Shirfrin (eds.), 1974, Hydrophysical and Hydrooptical Investigations of the Atlantic and the Pacific Oceans. Addendum 4, p. 320-325.

131. Kadishevich, E. A. and Yu. S. Lyubovkeva (1974). Matrices of Light Scattering by the Waters of the Southern Subtropical Convergence. In: Monin and Shifrin

(eds.), 1974, Hydrophysical and hydrooptical investigations in the Atlantic and the Pacific Oceans. Addendum 3, p. 317-320.

132. Kalle, Kurt (1937). Nährstoff-Untersuchengen als hydrographisches Hilfsmittel zur Untersuchung von Wasserkorpern. Annalen der Hydrographie und der Marit. Meteorol. (65), 1-18.

Cited in Visser (1969) as source of optical data for the North Sea.

133. Kalle, Kurt (1953). Der Einfluss des englischen Küstenwassers auf den Chemismus der Wasserkörper in der südlichen Nordsee. Berichte der Deutschen wissenschaftlichen Kommission für Meeresforschung, Neue Folge (13), 130-135.

Cited in Visser (1969) as source of optical data for the North Sea.

134. Kalle, K. (1961). What Do We Know About the Gelbstoff. In: Symposium on Radiant Energy in the Sea, N. G. Jerlov (ed.), Int. UGG Monography (10), 59-62.

A discussion is given of the optical and chemical properties of a mixture of different organic compounds known as "Gelbstoff."

135. Kalle, K. (1966). The Problem of the Gelbstoff in the Sea. Oceanography and Marine Biological Annual Review (4), 91-104.

The optical properties and distribution of Gelbstoff in the sea is given. At the long-wave (red) end of the visible spectrum, light is totally transmitted through Gelbstoff. As the wavelength decreases to the violet end of the spectrum, light is increasingly absorbed.

136. Kampa, E. M. and B. Boden (1957). Light Generation in a Sonic Scattering Layer. Deep Sea Research (4), 73-92.

Luminescence at the depth of the sonic scattering layer in the San Diego Strait was recorded at various times of day and night with a telerecording bathyphotometer. The color of the luminescence from the sonic-scattering layer was determined by using interference filters with the photometer. The independence of the light generated at depth from that incident on the sea surface was established by a comparison of the colors of the two. The luminescence from the scattering layer is blue-green; the emission is maximal near 478 nm.

137. Kampa, E. M. (1961). Daylight Penetration Measurements in Three Oceans. Union Geod. Geophys. Intern., Monographie (10), 91-96.

Extinction values for the waters off Bermuda, California, the Sargasso Sea, and the Mediterranean at various depths.

138. Kampa, E. M. (1970). Underwater Daylight and Moonlight Measurements In the Eastern North Atlantic. J. Mar. Biol. Assn., U.K. (50), 397-420.

139. Kampa, E. M. (1970). Underwater Daylight Measurements in the Sea of Cortez. Deep Sea Research (17), 271-280.

Observations of ambient light to depths of 300 meters were made in the Guaymas Basin (26°55'N, 111°24.5'W) and Farallón Basin (25°31'N, 109°52'W) in the Gulf of California, Sea of Cortez. Instruments used were a surface scalar irradiance meter with an RCA 931-A multiplier phototube sensor, and Schatt BG12 and GG5 filters which transmit in the band 320-640 nm, and a bathy-thermo-irradiance meter with a 931-A multiplier phototube used with filters to examine the spectral region from 408 to 533 nm.

140. Kampa, E. M. (1976). Photoenvironment and Vertical Migrations of Mesopelagic Marine Animal Communities in Biological Rhythms in the Marine Environment. P. J. DeCourgey (ed.), 257-272.

Curves representing irradiance attenuation of transmitted midday light (470-480 nm) at depths greater than 200 m in various oceanic regions, and at depths of 50 to 500 m from measurements taken north of Santo Antao in the Cape Verde Islands.

141. Kamykowski, D., et al. (1978). Biological Characterization of the Nepheloid Layer, Chapter 15, Environmental Studies of South Texas Outer Continental Shelf, Biology and Chemistry. Supplemental Report to Bureau of Land Management, Contract No. AA550-CT6-17.

Quantum irradiance attenuation measured with a LAMBDA photometer, beam attenuation measured with a Martek transmissometer (528 nm) and Secchi data collected in South Texas area from June through November 1978.

142. Karabashev, G. S., K. P. Zangalis, A. N. Solov'yev, and V. V. Yakubovich. (1971). New Data on Sea Water Photoluminescence. Izv. Akad. Nauk. SSSR Ser. Fiz. Atmospheric and Oceanic Physics (7:1), 60-68. [In Russian] Atmospheric and Oceanic Physics (7:1), 37-42.

The vertical profiles of transparency, temperature, and intensity of sea water photoluminesce in the Baltic Sea was determined. An on-board spectrofluorometer was used to measure the photoluminescence spectra excited by the 365 and 406 nm Hg lines by a technique that avoids contamination of the probe.

143. Karabashev, G. S. and K. P. Zangalis (1971). Some Results of Photoluminescence Spectra of Sea Water. Izv. Akad. Nauk SSSR. Ser. Fiz., Atmosfery, Okeana (7:9), 671-672.

Photoluminescense spectra, salt content, pH, composition of suspensions and "Gelbstoff" content measurements were made in the middle of the Baltic Sea, the Gulf of Riga and the mouths of Venta and Daugave rivers. A discussion is made of the possible link between photoluminescense spectra and the measured variables of the medium.

144. Karabashev, G. S. and A. N. Solov'yev (1974). Distribution Laws Governing Photoluminescent Intensity of Sea Water in the Active Layer. FAiO (8), 989-899.

An empirical formula is given expressing intensity of photoluminescence as a function of depth down to 250 meters, i.e., the interval over which photoluminescence tends to increase. Contribution of both biological and hydrological factors is discussed, with detritus of phytoplankton being a

major determinant. Within the tested area, including the Eastern Carribbean and part of the Sargasso Sea, five discrete types of photoluminescence characteristics could be identified, which are illustrated graphically.

145. Karabashev, G. S., A. N. Solov'yev, and V. V. Yakubovich (1974). Influence of Hydrologic Conditions on the Optical Characteristics of the Active Layer of the Ocean. Oceanology (4), 498-503 (Eng. trans.).

The spatial variations of the optical scattering intensities and photoluminescence of ocean water are compared on the basis of field measurements with the variations of the current, temperature, oxygen content, and salinity in the western part of the Atlantic Ocean. It is shown that features of the horizontal and vertical structure of the optical characteristic fields are governed by transport and transformation of biogenic suspended matter. The increase with depth of the content of substances responsible for changes in the optical absorption index in the ocean makes it necessary to develop an optical model of the ocean that takes account of the variability both of the suspended matter and of the dissolved organic substances. (Measurements made on 12th voyage of R/V AKADEMIK KURCHATOV.) [Okeanologiya (14:4), 623-629, 1974 - in Russian.]

146. Karabashev, G. S., A. N. Solov'yev, and V. V. Yakubovich (1974). Trudy Arkticheskogo Antarkticheskogo Inst., Ed. Gidrometeoisdat, Leningrad (284), 202.

Natural underwater illustration in the Black Sea and the Atlantic Ocean.

147. Karabashev, G. S. and A. N. Solov'yev (1974). Patterns of Spatial Intensity Distribution of Ocean Water Photoluminescence in the Active Layer of the Ocean. Deponirovano v VINITI (Text deposited at All-Union Institute of Science and Technical Information), (574).

148. Karabashev, G. S. (1975). Indication of Current to the East from Madagascar from Data of Fluorometric Measurements. Gidrofizicheskiye i Opticheskiye Issledovaniya v Indiyskom Okeane, Moskva (FSL20984), 93-95.

In the tenth voyage of the scientific research ship DMITRIY MENDELEYEV, attempts were to verify the possibility of indicating currents by fluorometric observations in any oceanological situation, having measured the vertical contour of the intensity of sea water photoluminescence in two cross sections to the east of Madagascar using the IPF-70 submersible impluse fluorometer (2). Fluorometric observations in the region of Madagascar supported the conclusion made earlier concerning their fitness in cross to identify currents and concerning the advantages of using sea water photoluminescent intensity as an indicator compared to measurements.

149. Karabashev, G. S., A. N. Solov'yev, and K. P. Zangalis (1974). Photoluminescense of the Atlantic and the Pacific Waters. In: Monin and Shifrin (Eds.) Hydrophysical and Hydrooptical Investigations of the Atlantic and Pacific Oceans. Chapter 9, pp. 143-153.

150. Kattawar, George W. and Gilbert R. Plass (1975). Asymptotic Radiance and Polarization in Optically Thick Media. Ocean and Applied Optics (15:12), 3266-3178, Dec.

Deep in a homogeneous medium that both scatters and absorbs photons, such as a cloud, the ocean, or a thick planetary atmosphere, the radiance decreases exponentially with depth and the angular dependence of the radiance and polarization is independent of depth. In this diffusion region, the asymptotic radiance and polarization are also independent of the incident distribution of radiation at the upper surface of the medium.

151. Kazanowska, Maria (1971). Suspended Matter in Monterey Bay, California: Some Aspects of Its Distribution and Minerology. M.S. thesis, Naval Postgraduate School, Monterey, California, Sept., 84 p.

The distribution of suspended particulate matter in Monterey Bay, Calif., was characterized by the ratio of light scattering at 45° to that at 135° by particle volume distribution, and by constituent distributions.

152. Keating, J. H. (1966). A Climatic Isovisic and Nephanalysis Atlas of the North Atlantic, North Pacific and Indian Oceans. Mitre Corp., Bedford, Mass., Rept. No. MTR-145, 154 p.

In support of the NRDL optical sensor study climatological charts are provided for the season months of January, April, July and October for the North Atlantic, North Pacific and Indian Oceans. The climatological charts provide: (1) Isovisic (visibility) maps of the percentage frequency of visibilities less than 25, 10, 5, 2 and 1 nm: (2) Isovisic maps of visibility for 90, 75, 50 and 25%: (3) Nephanalysis maps of the percentage frequency of total cloud cover greater than or equal to seven-eighths (greater than or equal to 7/8): (4) Nephanalysis maps of percentage frequency of total cloud cover equal to or less than two-tenths (less than or equal to 2/10).

153. Kelly, Mahlon G. (1968). Visible Region Instruments for Satellite Oceanography. Tech. Paper, 9th Meet. Ad. Hoc. Space Oceanog. Adv. Gp., 23-25 Jan 1968. Spacecraft Oceanography Project, NAVOCEANO, Washington, D.C.

Investigation of the use of aerial photography of shallow water bottom features as a means of characterizing and analyzing oceanic environmental parameters. Detailed studies were made in the Bahama Bank area.

154. Ketchum, B. H. and D. H. Shonting (1958). Optical Studies of Particulate Matter in the Sea. Woods Hole Oceanogr. Inst. Ref. 58:15, 28 p.

A study of particulate matter distribution using the light scattering photometer was made on the "Atlantis" cruise No. 240 to the Cariaco Trench in the Caribbean Sea. Discussion of the light-scattering data of the trench waters and a comparison of the light scattering data and Secchi disk reading of both the trench and the centinetal shelf waters is included.

155. Khalemsky, E. N. and V. I. Voitov (1972). "The Division of the Pacific Based on Transparency." In: Shifrin, K. S. (Ed.) Optics of the Ocean and the Atmosphere, 181-187.

The Pacific waters are classified based on transparency, and hydrooptical regions in the Pacific are located and tested by means of statistical methods.

156. Kiefer, Dale A. and R. W. Austin (1974). The Effect of Varying Phytoplankton Concentration of Submarine Light Transmission in the Gulf of California. Limnol. and Oceanog. (19:1), 55-64.

> Beam transmission and phytoplankton fluorescence were measured simultaneously in the Gulf of California. In each profile the depth distribution of the volume attenuation coefficient, alpha, corrected for the attenuation by particle-free water, paralleled the distribution of the phytoplankton fluorescence.

157. Kielhorn, W. V. (1952). The Biology of Surface Zooplankton of a Boreo-Arctic Atlantic Ocean. Journal Fish Research Board, Canada (9), 223-264.

> Weekly surface zooplankton samples were taken at International Ocean Station "B" (56°30'N, 52°00'W) in the Labrador Sea. Samples and bioluminescence incidence were measured for one year. Transparency varied with phytoplankton concentrations and is not affected by zooplankton numbers. No correlation was made between the bioluminescence and the causative organisms. The highest bioluminescence incidence was given as being during the summer and autumn. In all, 61 species of 7 phyla were recovered by nets.

158. Kinder, Floyd A. (1966). Underwater Light Attenuation Measurements. Naval Ordnance Test Station, China Lake, Calif., Rept. NOTS-TP-4148., Jul.

> Measurements taken near San Clemente Island of the volume attenuation coefficent, diffuse attenuation coefficient and spectrographic characteristics. Volume attenuation coefficient taken in the North Pacific at depths to 6000 ft are presented.

159. Kinney, Jo Ann S., S. M. Luria, and Donald O. Weitzman (1967). Visibility of Colors Underwater. J. Opt. Soc. Am. (57:6), 802-809.

> The underwater visibility of various colors, both fluorescent and non-fluorescent, was measured in four different bodies of water. The waters were selected to sample the continuum from very murky to clear. SCUBA divers observed with a horizontal path and other subjects on the surface looked down vertically. Locations are: Thames River near Sub Base, Long Island Sound in Fort Pond Bay, Gulf of Mexico off Panama City, and Morrison Springs, Fla.

160. Kirk, J. T. O. (1976). Yellow Substance (Gelbstoff) and Its Contribution to the Attenuation of Photosynthetically Active Radiation in Some Inland and Coastal Southeastern Australian Waters. J. Australian Mar. Freshwater Res. (27), 61-71.

> The absorption spectra relative to distilled water of samples from various inland and coastal waters in S.E. Australia have been measured. Water samples are passed through 0.22 μm filters. Coastal water concentration of Gelbstoff was found to be much lower than any of the fresh water samples. From 60% to 80% of the quanta is captured by the yellow substance and not by water. The absorption coefficient of Gelbstoff at 440 nm is measured as representative of the attenuation experienced by the incident photosynthetically active radiation.

161. Kobletz-Mishke, O. I. and Yu. E. Ochakovsky (1966). *On the Light Measurement in the Study of Primary Production in the Sea.* Okeanologiya (6:3), 535-542.

Two methods were suggested to standardize the photosynthetic radiation measurements in the sea: 1) direct measurement of energy using thermopile detectors and 2) calculation of energy values from the output readings of photoelectric detectors. Each method has its own advantages and disadvantages. The authors suggest the use of Jerlov's optical classification with the addition of some improvements. Application of Jerlov's tables makes it necessary to standardize light measurements by the spectral sensitivity of the detectors.

162. Kohnke, D. (1969). On the Value of Attenuation Measurements in an Upwelling Area. International Council for the Exploration of the Sea C. M. 1969/C:5, Hydrography Committee.

Ninety-three alpha-meter lowerings at 57 different stations off the coast of NW Africa between 19° and 22°N are reported (actual data not given).

163. Kozlyaninov, M. V. (1960). Some Optical Characteristics of Waters in the Central Part of the Pacific Ocean. Trudy Instituta Okeanologil AN SSSR (40), 167-174.

164. Kozlyaninov, M. V. and I. M. Orchinnikov (1961). Relationship between Transparency of Water and Currents in North Eastern Pacific. Trudy Institute Okeanologil AN SSSR (45), 102-112.

165. Kozlyaninov, M. V. (1961). A Manual on Hydrooptical Measurements at Sea. Also on the relation of transparency with the nature of the currents of the Northeastern Pacific. Institute of Oceanology of Academy of Sciences USSR (47).

166. Kozlyaninov, M. V. (ed.) (1965). Investigations in Hydrooptics. Academy of Sciences of the USSR, Transactions of the Institute of Oceanology (77) Publishing House NAUKA, Moscow, 137 p.

Descriptions of instruments and theoretical work by Russian scientists (in Russian with English abstracts).

167. Krishnan, K. S., R. C. Honey, W. E. Evans, and G. P. Sorenson (1969). Development of a Turbidity-Measuring Underwater Optical Radar System. Stanford Research Institute, Menlo Park, Calif., SRI Report 7325, Office of Naval Research, Department of the Navy, Washington, D.C.

The results of a feasibility study of measuring subsurface turbidity in the ocean are presented. The design and development of the laser transmitter and receiver packages of an underwater optical radar system are discussed. The initial performance of the equipment in three field trials in the Pacific Ocean is described, the data obtained is discussed, and the system is evaluated.

168. Krumboltz, H. (1979). Experimental Investigation of System Attenuation Coefficient for HALS. Naval Air Development Center, August, Report NADC 80035-30.

A flight test of a laser radar system installed in an SH-3 helicopter was conducted near Key West, Florida. Data were obtained to show the relationship of alpha, K, and system attenuation coefficient applicable to the Hydrographic Airborne Laser Sounder (HALS) System. Results show that K is useful in predicting HALS performance.

169. Kullenburg, G. (1967). In Situ Measurements of Horizontal and Vertical Diffusion in the Thermocline in Swedish Coastal Waters. Univ. of Copenhagen.

170. Kullenberg, Gunnar (1968). Scattering of Light by Sargasso Sea Water. Deep Sea Res. (15), 423-432.

This experimental investigation deals with the problem of the scattering of light by very clear ocean water. The forward scatterance was measured close to a laser beam using a new measuring device. The forward particle scatterance was found to be virtually independent of wavelength, whereas the backward scatterance was dependent on the wavelength. The water investigated has a high degree of clearness compared with other areas. The ratio of scatterance at 45° to total scatterance over all angles was found to vary within narrow limits for different oceanic areas.

171. Kullenberg, Gunnar (1969). Light Scattering in the Central Baltic. Kobenhavns Universitet Institut for Fysisk Oceanografi, Report No. 5, Copenhagen.

172. Kullenberg, G., B. Lundgren, S. Malmberg, K. Nygard, and N. Hojerslev (1970). Inherent Optical Properties of the Sargasso Sea. Kobenhavns Universitet Institut for Fysisk Oceanografi, Report No. 11, Copenhagen, 18 p.

173. Kullenberg, G., B. Lundgren, A. A. Malmberg, K. Nygard, and N. Hojerslev (1974). Inherent Optical Properties of the Sargasso Sea. Kobenhavns Universitet Inst. for Fysisk Oceanografi, Rept. (11), 1-11.

174. Kumagori, T., K. Kagata, and H. Suzuki (1958). Measurements of the Intensity of Submarine Daylight in the Northwest Pacific and Indian Ocean. Tokyo Univ. Fisheries J. (1:2).

175. Labyak, Peter S. (1969). An Oceanographic Survey of Coastal Waters Between San Francisco and Monterey, California. M.S. Thesis, Naval Postgraduate School, Monterey, Calif., October, 317 p.

A detailed oceanographic survey of the coastal waters between Monterey Bay, California, was conducted from 10 through 18 May 1969. Measurements of beam transmittance, sound velocity, temperature, and particulate count were obtained. Over 500 samples were taken for particulate analysis.

176. LaFond, E. C. and J. Sivarama Sastry (1957). Turbidity of Waters Off the East Coast of India. J. Indian Meteorological Geophysical (8), 183-192.

The seasonal variability of water turbidity off the Indian east coast (Bay of Bengal) was measured with a hydrophotometer (transparency meter). The measurements were made within the visible spectrum, 300-700 nm, to depths of 20 meters.

177. LeNoble, Jacqueline (1955). Sur quelques mesures de la pénétration du rayonnement ultraviolet dans la Mediteranee et leur interprétation théorique. (On some measurements of the penetration of ultra-violet radiation in the Mediterranean and their theoretical interpretation.) C. R. Acad. Sci. Paris (241) 1407-1409.

> Measurements of natural ultra-violet radiation in the sea were made at Monaco during the summer of 1955 and have included the intensity of radiation propagated from the surface downward, from some depth upward, and horizontally. The results seem to be in agreement with both previous observed values and with theory.

178. Lepley, L. K. (1968). Coastal Water Clarity from Space Photographs. Photogrammetric Engineering, 667-674, July.

> Mapping ocean water clarity from space ship photography was shown to be feasible by studies of 70 mm color transparencies from GEMINI flights. A phototype global map of coastal ocean water turbidity was constructed on the basis of the relationship between water transparency and its color and the visibility of shoals. For comparison <u>in situ</u> transparency data taken by an oceanographic ship was mapped. The resulting global maps of coastal water clarity indicate that about 35% of the world's coastal sea floor can be mapped out to 20 m depth by aerial photogrammetry.

179. Levring, Tore (1965). Submarine Light and Algal Shore Zonation in Light as an Ecological Factor, R. Bainbridge, G. C. Evans and O. Rackhan (eds.), John Wiley & Sons, Inc., New York, 305-318.

> Spectral composition of radiant energy at different depths in coastal water off the east coast of Sweden and in the east Mediterranean. Relationship between irradiance and photosynthesis activity for <u>Cladophora crystallin</u> and <u>Delesseria sanguinea</u> at different depths.

180. Li, M. Ye. and O. V. Martynov (1976). Experimental Results of Color Index Studies in the Sea. Sb. Morshive Gidrofizicheskiye Issledoroniye (Sevastopol) (1:72), 133-138. RZhGeofiz, 11/76, No. 11V74.

> Some problems in the use of remote measurements in hydrooptics are discussed. A two-beam scheme is given for the determination of color index. Results of investigations carried out in various water areas of the world oceans are presented; they are: Gulf of Aden, Alboran Sea, Algerian Sea, Antilles, Arabian Sea, Central Atlantic, West African Coast of Atlantic, Balearic Islands, Black Sea, Ionian Sea, Marseilles Gulf of Lion's, Malacca Strait, Sea of Marmora, Mozambique Straits, Southern Ocean, Sardinia Tunis Straits, and Caribbean.

181. Likens, Gene E. and Philip L. Johnson (1968). A Limnological Reconnaisance in Interior Alaska. Dartmouth College, Hanover, New Hampshire, Research Report, June, 49 p.

> Chemical, physical and biological measurements were made in about 40 lakes and nine other aquatic habitats in interior Alaska, primarily in the Tanana and Yukon River Drainages. Light penetration into the lakes varied widely (extinction coefficient of 0.46/m to 3.57/m).

182. Lyzenga, David (1980). Environmental Research Institute of Michigan (ERIM), Personal Communication.

ERIM has water optical data from Bahamas; upwelling and downwelling irradiance with Kahl Scientific Instruments in four filters and bottom spectral reflectance measurements. Measurements are being taken in Great Lakes for evaluating CZCS (NASA/LANGLEY); volume scattering (spectral), beam attenuation (spectral), and absorption coefficient (spectral).

183. Lyzenga, D., R. Shuchman, C. Davis, and G. Suits (1979). Basic Remote Sensing Investigation for Coastal Reconnaissance. Environmental Research Institute of Michigan, Technical Report 1344-00-7T, June.

Features attributable to the reflection of light from the ocean floor are observable in remote sensing data for water depths less than 1-2 optical attenuation lengths. Information about the characteristics of the bottom and the water depth can be obtained by comparing the observed radiances in two or more wavelength bands with radiances calculated from a radiative transfer model.

184. Malmberg, Sv. A. (1964). Transparency Measurements in the Skagerrak. Model Oceanog. Inst. Goteborg (31), 18.

185. Manheim, Frank T. and Robert H. Meade (1970). Suspended Matter in Surface Waters of the Atlantic Continental Margin from Cape Cod to the Florida Keys. Science (167:3917), 371-376.

Evaluation of the relations between concentrations of suspended matter and measurements of the transparency and color of water (Secchi Disk).

186. Manheim, F. T., R. G. Steward, and K. L. Carder (1976). Transmissometry and Particulate Matter Distriubtion in the Eastern Gulf of Mexico Shelves, MAFLA Survey, 1975-1976. MAFLA Monitoring Study, Final Report to Bureau of Land Management, Contract 08550-CTS-30, vol. 1.

Beam attenuation data collected in 1975-1976 with a Hydroproducts transmissometer (550 nm) in Mississippi, Alabama, Florida gulf coastal waters.

187. Man'Kowskiy, V. I. (1973). Hydrology of the Pacific Ocean Containing Scattering Data. Morskiye Gidrofizicheskiye Isslgdovaniya 3 (62), 100-108, Sevastopol, M6I AN UK SSR.

Properties of indicatrixes extremal in the value of the coefficient of asymmetry and space angle containing a half of the whole scattered light flow are discussed based on the measurement of light scattering indicatrixes directly in the sea.

188. Matlack, D. E. (1971). The Deep Ocean Optical Measurement (DOOM) Program. NOLTR 70-165, U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Maryland.

A ship borne system is described and results of in situ measurements of the inherent optical properties of ocean water are presented. This Deep Ocean Optical Measurement (DOOM) system is designed to measure to any depth in the ocean spectral attenuation coefficients from 436 millimicrons

through an angular range from 6 to 92 degrees, and background illumination of both celestrial and biological origin. Representative data obtained from December 1967 through January 1970 on six measurement cruises to various areas of the Atlantic are presented. Future cruises and plans are discussed.

189. Matsuike, Kanau (1968). Study on the Optical Characteristics of Three Oceans, Part 1, Optical Structure of the Kuroshio (Japan Current) from Lat. 20°N to 31°N along the Meridian of 142°E. Tokyo Univ. Fisheries J. (53:1-2), 1-40, March 1967. (In English)

190. Matsuike, Kanau (1969). The Optical Characteristics of the Water in Three Oceans, Part III, the Distribution of Solar Energy Reached to and Penetrated in the Water of the Antarctic Ocean in the Summer and the Comparison to other Oceans. Tokyo Univ. of Fisheries, Japan, J. Oceanog. Soc. Japan (25:2), 81-90, April. (In English)

191. Maul, G. A. and H. R. Gordon (1975). On the Use of the Earth Resources Technology Satellite/Landsat-1 in Optical Oceanography. Remote Sensing of Environment (4:2), 95-128.

Observations of the Gulf Stream System in the Gulf of Mexico were obtained in synchronization with Landsat-1. Computer-enhanced images, which are necessary to extract useful oceanic information, show that the current can be observed by color (diffuse radiance) or sea state (specular radiance) effects associated with the cyclonic boundary even in the absence of a surface thermal signature. The color effect relates to the spectral variations in the optical properties of the water and its suspended particles, and is studied by radiative transfer theory. Significant oceanic parameters identified include the probability of forward scattering, and the ratio of scattering to total attenutation. Several spectra of upwelling diffuse light are computed as a function of the concentration of particles and yellow substance.

192. Mayor, Lester G. and Robert N. Swift (1975). Underwater Topography and Sea Truth of the Key West Test Area. Naval Oceanographic Office Internal Technical Note, Washington, D.C., October.

This detailed report describes an effort to obtain sea truthing data on the optical properties of shallow coastal water and bottom. The effort was in support of the test of an airborne laser bathymeter at Key West, Florida, in August 1974.

193. McCluney, W. R. (1974). Ocean Color Spectrum Calculations. Applied Optics, (13:10), 2422-2429.

Theoretical models have been developed to relate the oceanographic parameters to the upwelling radiances that ascribe the ocean color. The shape of the radiance spectrum predicted by this model for clear ocean water shows encouraging agreement with measurements made at the edge of the Sargasso Sea off Cape Hatteras.

194. McGrail, D. W., D. Huff, and S. Jenkins (1978). Current Measurements and Dye Diffusion Studies. Northwestern Gulf of Mexico Topographic Features Study, Final Report to Bureau of Land Management, Contract AA550-CT7-15, December.

Transmittance profiles graphed for ocean stations off Texas and Louisiana. Instrument used was a Martek transmissometer.

195. McNeil, W. R. and K. P. B. Thomson (1974). Remote Measurement of Water Color and Its Application to Water Quality Surveillance. Remote Sensing of Earth Resources, Vol. 3, Proceedings of the Third Conference on Earth Resources Observations and Information Analysis System, Tullahoma, Tennessee.

Correlation has been examined between the remotely measured data on the Great Lakes and the in situ parameters. Data from two different areas reveal tnat the intrinsic water color parameters that are pertinent to water quality can be obtained by remote measurements. A theoretical model has been developed which can be used to investigate the behavior of the spectral response of the volume reflectance as a function of suspended sediment and chlorophyll concentration.

196. Medvedev, V. S. and N. M. Krivonosova (1964). Investigation of Quantitative Distribution of Suspension in Coastal Waters of the White Sea. Acad. Sci. USSR, Oceanology (8:6), 792-803.

Data on the quantitative content of suspension at 109 stations in Dvina, Ognega and Megen Bays and the northern part of the White Sea are presented.

197. Merrifield, Roger (1964). Prediction of Sea Surface Conditions from Ambient Light Measurements at Depth in the Arctic Ocean. Marine Sciences Dept., U. S. Naval Oceanographic Office, Washington, D.C., Informal Manuscript Report 0-46-63, 14 p., February.

A sonic depth transducer and a photocell were mounted on a submarine, both directed upward to simultaneously measure the ice cover and ambient light level while submerged. The measurements were taken 12 July through 26 August 1962 in the Pacific and Arctic Oceans.

198. Michelini, R. T. (1971). Spectral Radiance Measurements in Monterey Bay. M.S. thesis, Naval Postgraduate School, Monterey, Calif., September, 86 p.

An underwater spectral radiance meter having a rotating spectral wedge filter and capable of operating to depths of 300 meters was designed and constructed. It was used to obtain measurements of spectral radiance to a depth of 60 meters at two stations in southern Monterey Bay, Calif., on an overcast day in July 1971. Variations of the spectral radiance distributions with depth were plotted in vertical angles of 0, 45, 90, 135 and 166 degrees at an azimuth angle of zero degrees with respect to the sun.

199. Mine Warfare Pilot. Special Publications, 800-900 Series (U). U. S. Naval Oceanographic Office, NSTL Station, Mississippi (CONFIDENTIAL to SECRET). Water transparency measurements by Secchi disk in various worldwide ocean areas (in section 17). Series 800 is Pacific; 900 series is Atlantic.

200. Monin, A. C. and K. S. Shifrin (1974). Hydrophysical and Hydrooptical Investigations in the Atlantic and the Pacific Oceans. Publishing House NAUKA, Moscow, 328 p. (In Russian).

Reviews Russian work in optical oceanography and discusses the interdisciplinary application of this data. Includes radiative transfer theory and recent data.

201. Moore, H. B. (1949). Atlantic Cruise 151 to Mediterranean Area. Scattering Layer Observations. Rept. 49-2, 6 p., Woods Hole Oceanographic Institution, Mass.

Fathograms were obtained continuously thoughout the cruise, and cover practically the whole of the Mediterranean with the exception of the Adriatic and the part of the western Mediterranean north of about latitude 39 degrees north.

202. Moore, H. B., H. Owre, E. C. Jones, and T. Dow (1953). Plankton of the Florida Current. 3. The control of the vertical distribution of zooplankton in the daytime by light and temperature. Bull. Mar. Sci. Gulf and Carib. (3:2), 83-95.

203. Moore, H. B. and E. G. Corwin (1956). The Effects of Temperature, Illumination, and Pressure on the Vertical Distribution of Zooplankton. Bull. Mar. Sci. Gulf and Carib. (6:4), 273-287.

204. Morel, Andre (1965). Interpretation des variations de la forme de l'indicatrice de diffusion de la lumiere par les eaux de mer. Annales de Geophsique (21:2), 281-284.

It appears that the variations of the volume scattering function for natural sea waters could be explained by considering the part of the scattering due to the water itself and the part due to the suspended particles. The scattering effected by particles would exhibit an almost unchanging function. This feature is revealed using samples from the Channel, the Tyrrhenian Sea, the Mediterranean Sea, and from the bay and off Villefranche sur Mer. Moreover, the scattering coefficient at right angles for optically pure sea water is determined: 0.064 [O_6H_6 = 1.00] at a wavelength of 546 nm.

205. Morel, A. L. (1973). Diffusion de la Lumiere par les Eaux de Mer. Resultats Experimentaux et approche theorique. In: AGARD Lecture Series No. 61 on Optics of the Sea (Interface and In-Water Transmission and Imaging), (Technical Editing and Reproduction Ltd., London, August), 31-1-3-1-76.

206. Morel, A. L. (1974). Optical Properties of Pure Water and Pure Sea Water. In: N. G. Jerlov and E. Steemann Nielsen (eds.), Optical Aspects of Oceanography, Academic Press, 1-24.

Attenuation curves on p. 19 in the near violet and visible part of the spectrum at various path lengths for pure water and pure sea water.

207. Morel, Andre and Louis Prieur (1977). Analysis of Variations in Ocean Color. Limnol. and Oceanog. (22:4), July, 709-722.

Spectral measurements of downwelling and upwelling daylight were made in waters different with respect to turbidity and pigment content, and from these data the spectral values of the reflectance ratio just below the sea surface were calculated. Included are spectral reflectance curves for five stations from data obtained in the Sargasso Sea for 400-700 nm

wavelengths in Figure 5, and spectral reflectance curves for various blue and green waters from data obtained on the DISCOVERER Cruise and the CINECA 5-CHARCOT cruise.

208. Morel, Andre L. and Howard R. Gordon (1980). Report of the Working Group on Water Color. Boundary Layer Meteorology (18), 343-355.

This report on water "color" is divided into two parts: a summary of the formal and informal presentations made at the meeting, and a summary of the conclusions and recommendations reached during the working group meetings. The group's discussions were divided into four categories: inwater studies and algorithms, atmospheric effects and correction algorithms, design of the next generation of spacecraft sensors, and future projects.

209. Morel, Andre (1980). In Water and Remote Measurements of Ocean Color. Boundary Layer Meteorology (18), 177-201.

Spectral measurements of downwelling irradiance, above the surface, and of upwelling irradiance just below the surface, allow computation of spectral values of the diffuse reflectance; this yields full information about the true color and brightness of the ocean. Typical results are presented and interpreted for waters very different in turbidity and phytoplankton content. Includes data obtained during Discoverer - WG15 Cruise and CINECA-5 Charcot cruise (near Pacific entrance to Panama Canal and shallow regions off Mauritania, curves of spectral upwelling irradiance and upwelling radiance from the water near Marseille (43°27.1N - 5°06.7E) in Figure 9, spectral downwelling and upwelling irradiance at 43°20.0N - 4°57.0E near Marseille in Figure 10, and spectral upwelling nadir radiances from the Mediterranean Sea between Nice and Corsica (Fig. 11).

210. Morita, J. (1973). Transparency Observed by the Secchi Disc in the Western Pacific Ocean. Far Seas Fisheries Research Laboratory Bulletin (9), 1-18.

211. Morrison, Robert E. (1967). Studies on the Optical Properties of Seawater at Argus Island in the North Atlantic Ocean and in Long Island and Block Island Sound. Ph.D. Thesis, New York University, University Microfilms, Inc., No. 68-6089, Ann Arbor, Michigan.

212. Morrison, R. E. (1968). Optical Properties of the North Atlantic Ocean at Argus Island. U. S. Naval Air Development Center, Johnsville, Penn., Report No. 32.

The attenuation coefficient, the relative irradiance, and the volume scattering functions were measured at 5300A° as a function of depth and time of day.

213. Morrison, R. E. (1970). Experimental Studies of the Optical Properties of Sea Water. J. of Geophys. Res. (75:3), 612-628.

Attenuation, absorption and total scattering coefficients of sea water at 5300 A° were obtained nearly simultaneously from experimental observation at the Argus Island tower in the North Atlantic, in Long Island Sound, and in Block Island Sound. A unique _in situ_ instrument permitted

scattering measurements at a minimum forward angle of 0.2°. Depth profiles of the three coefficients exhibit an overall agreement with simple theorectical predictions within a factor of 2. Cofficients measured in Long Island Sound were about a factor of 10 larger than those from the North Atlantic station, and the coefficients from Block Island Sound were intermediate.

214. Morrison, R. (1970). Optical properties of Sea Water of the North Atlantic Ocean at Argus Island and Block Island Sounds at Long Island. U. S. Naval Air Development Center, Aero-Electronic Technology Department, Johnsville, Warminster, Penn. Report No. NADC-6918, 73 p.

Attenuation, absorption, and scattering coefficients were obtained from nearly simultaneous optical measurements at sea. The total scattering coefficients were computed for 159 samples from data obtained with two scattering meters, one of which was capable of measuring the volume scattering function at 0.2°. Depth profiles of the optical properties were compared for consistency, and overall agreement within a factor of two was observed. Consistent agreement between an increase in the turbidity and the top of the seasonal thermocline were demonstrated by data profiles from Argus Island. The light attenuation distributions at the coastal stations were influenced by the tidal cycle and fresh water run-off.

215. Murdock, John H. (1980). The Transparency of Southeast Asian and Indonesian Waters. M. S. Thesis, U. S. Naval Postgraduate School, Monterey, Calif., March.

Secchi data (transparency) were obtained for Southeast Asian and Indonesian waters from 20°S to 30°N and from 90°E to 140°E. Some 10,269 points were used to determine the seasonal variation of transparency from specific subregions and depths. Seasonal and annual charts of Secchi depth (Z_s) were made for 16 subregions. The irradiance attenuation coefficient (K) was computed from Z_s.

216. Mueller, J. L. (1976). Ocean Color Spectra Measured off the Oregon Coast: Characteristic Vectors. Applied Optics (15:2), 394-402.

Ocean color spectra (ratio of upwelling light to incident light), observed from an airplane flown over waters off Oregon, are analyzed. The original spectra is resolved into 55 wavelength bands each 5 nm wide (between 420 and 695 nm). Y_i are the scalar projections of each spectrum on the first four characteristic vectors of the sample covariance matrix. Regression equations are found with which phytoplankton pigment concentration and water transparency may be estimated as linear functions of the parameters Y_i. Pigment concentration estimates obtained by this method are found to be imprecise.

217. Mullamaa, Yu. A. R. (1964). Atlas of the Optical Characteristics of a Distorted Sea Surface. Published by the Akad. Sci. Estonian SSR (1964).

218. Munday, J. C., Jr. (1974). Lake Ontario Water Mass Delineation from ERTS-1. Ninth International Symposium on Remote Sensing of the Environment, Ann Arbor, Mich. (2), 1355-1368.

> Multiband analysis of ERTS-1 MSS photographic images of western Lake Ontario was conducted to delineate water masses. Modification of water hues by thin cloud cover was detected by chromaticity analysis. Density-sliced MSS images indicate suspended sediment plumes near river and harbor mouths, in near-shore zones and discoloration in scattered areas. Need is pointed out for a long-term ERTS mapping project to obtain a useful satellite picture of the Lake Ontario circulation dynamics.

219. National Oceanographic Data Center, Washington, D.C. (1974). Sechhi Data Collected from 1952 to 1974, Oregon and Washington Waters. Total of 1329 data observations on magnetic tape.

220. Naval Oceanographic Office (1975). An Image Contrast Engineering Analysis of Aerial Photography for Water Depth Penetration at Key West, Florida, Test Area. Informal Report, Hydrographic Development Division, Ocean Engineering Department, Naval Oceanographic Office, Washington, D.C., February, 8 p.

> Instruments used to measure the various optical property in this test were filtered to provide maximum transmission in the green portion of the spectrum. The reflectance of the water, R_B; the diffuse attenuation coefficient, K, and the volume attenuation coefficient were measured or calculated from measured values, *in situ*.

221. Nelepo, B. A., A. S. Lezhen, A. L. Kravtsov, and G. K. Korotayev (1977). Laser Altimeter as a Method for Satellite Observations of Level Variations in the World Oceans. (Sb. Nekontakt, metody izmeremiya Okeanogr. parametrov.) M. Gidrometeoizdat, 1977, 121-124. RZH Geofiz., 11/77, no. 11V36.

222. Neshyba, S., G. F. Beardsley, Jr., V. T. Neal, and K. Carder (1968). Light Scattering in Central Arctic Ocean: Some Winter Profiles. Science (162), 1267-1268, 13 December.

> Measurements for light scattering in the Arctic water column reveal strong gradients and variability of the order of 15 percent in depths of less than 500 meters. The region of variability appears to persist from day to day and is roughly associated with the typical hydrographic features of the region.

223. Neuymin, G. G., N. A. Sorokina, A. N. Paramonov, and V. N. Proschchin (1964). Hydrophysical investigations. Some results of the optical investigations in the Northern Part of the Atlantic Ocean (7th cruise of S.R. ship "Mikhail Lomonosov"). Tr. Morsk. Gidrofiz. Issled. Akad. Nauk S.S.S.R. (29) 64-75. Eng. trans.: Soviet Oceanography (29:1), 43-52, 1964.

> During the seventh voyage of the research vessel "Mikhail Lomonosov" optical measurements were included in the program of hydrophysical investigations and, therefore, the results of these measurements can be correlated with those of hydrological and biological investigations. The following hydro-optical values were measured during this voyage: the transparency (extinction coefficient) of ocean waters (in 5 regions of the

visible portion of the spectrum and in white light), the underwater illumination of a horizontal surface by light propagating downward and upward (in 4 regions of the visible portion of the spectrum), depth to which a white disk is visible, and the color of water (according to the standard method) This article reports some of the results of the analysis of optical measurements.

224. Neuymin, G. G. and A. N. Paramonov (1965). Distribution of Suspended Matter in the Deep Parts of the Black Sea. Izvestiya AN SSSR, Fizika Atmosfery i Okeana (1:11), 1190.

225. Neuymin, G. G., A. N. Paramonov, Ye. A. Agafonov, and S. V. Karaush (1966). Investigations in the Southwestern Part of the Norwegian Sea and the Northeastern Part of the Atlantic Ocean. Naukova Dumka, Kiev [In Russian].

226. Neuymin, G. G., A. N. Paramonov, Ye. A. Agafonov and S. V. Karaush (1966). Distribution of Suspensions in the Bottom Layers of the Sea. Ekspress-inf. Inst. Marine Geophys. Ukr. Acad. Sci. (3).

Reports near bottom beam attenuation measurements.

227. Neuymin, G. G. and Yu. A. Anikin (1968). Measurement of Underwater Illumination in the Black Sea. Trudy Inst. Marine Geophys., Ukr. Acad. Sci. No. (37).

228. Neuymin, G. G., Yu. A. Anikin, and N. A. Sorokina (1968). Natural Underwater Illumination in the Black Sea and the Atlantic Ocean. Trudy Arkticheskogo Antarkticheskogo Inst., Ed., Gidrometeorsdat, Leningrad (284), 202 p.

229. Neuymin, G. G. (1973). Optical Studies of Black Sea Water. Materialy Vses. simpoz. po izuchennosti. Chern. i Srediznm. morey, ispol'z. i okhrane ikh resursov. Sevastopol', Part I. Kiev, Naukova Dumka, 1973, 81-83 (R. Zh. Geofiz., no. 5, 1974, 5V104).

Many areas of the Black Sea have layers exhibiting reduced transparency at depths of 100-180 meters, where there is a layer of suspended matter supported by upward flows. Studies using transparency meters have revealed that these layers often are [optically] detectable only when the instrument is moving, and transparency seems to vanish when the instrument is not in motion. These layers are thought to be related to large zooplankton which are frightened by the instrument. In situ spectral measurements of extinction indicate an increase with depth of some substances which selectively attenuate shortwave radiation. Spectral curves for the vertical extinction coefficient and the "color index" values (ratio of luminances of light exiting the sea at the 540 and 450 mμ wavelengths) indicate a high yellow-substance content in the Black Sea. The corresponding attenuation factor is approximately 10 times greater than for the central tropical Atlantic, and three times greater than for the northwestern Mediterranean Sea.

230. Neuymin, G. G. and N. A. Sorokina (1976). Correlation Between the Vertical Distributions of Optical and Hydrologic Characteristics in the Ocean. Oceanology (16:3), 245-250.

The data illustrated in this report is from measurements in the tropical Atlantic (along 30°W), along the 18°W meridian from Dakar to the equator, and the Atlantic region south of the Grand Banks.

231. Nielsen, J. H. and E. Aas (1977). Relation Between Solar Elevation and the Vertical Attenuation Coefficient of Irradiance in Oslofjorden. U. of Oslo, Report 31, 42.

232. Nikolayev, V. P. and A. A. Zhil'tsov (1959). Simple Photoelectric Transparency Meter. Okeanologiya (4:2), 1964. Acad. Sci. USSR, Oceanology (8:3), 428-432, (1968).

A new portable photoelectric transparency meter was tested in the Black, Red, and Mediterranean Seas. The simplicity of the device and its independence of external power supply (it uses storage batteries) permits its use in limited research from ships and smaller craft.

233. Nikolayev, V. P., V. G. Yakubenko, A. A. Zhil'tsov, V. K. Tutobalin, V. M. Pavlov, and M. S. Zhulapov (1976). Hydrooptical Studies on the "Self-Black Sea" Program. Okeanoligiya (16:3).

234. Nishizawa, Satoshi and Naoichi Inoue (1958). Turbidity Distribution and Its Relation to Some Oceanographical Factors in the Eastern China Sea in the Late Summer of 1956. Records Oceanog. Works Japan, Special No. 2, March 1958, 101-115.

The turbidity distribution in the Eastern China Sea in the late summer of 1956 was observed by a turbidity meter of simple structure. Several water masses were distinctly analysed by the extinction coefficient observed. Sharp knees of turbidity occurred at the spring layer of density were noticed and explained by the sudden decrease of vertical eddy diffusivity. The existence of distinct minimum of turbidity at the maximum density gradient was especially demonstrated and the development of intensive mixing in horzontal direction at the spring layer was suggested. In the oceanic homogeneous water to the right of the Kuroshio axis, the downward transport of suspended detritus was calculated from the the observed vertical distribution of turbidity and phyto-plankton production at each level was also discussed. Several water masses were distinctly analysed by the extinction coefficient observed. Stations were between 32°E 122°E, 32°E 132°E and 27°E 122°E and 27°E 132°E.

235. Nishizawa, S., N. Inoue, and T. Akiba (1959). Turbidity Distribution in the Subarctic Water of the North Pacific in the Summer of 1957. Records Oceanog. Works Japan, Spec. No 3: 231-241.

236. Nygard K. (1968). Measurements with a Quarta Meter During WAIS Sea Trials in the Gulf of California, May 5th - 16th 1968. Kobenhavns Universitet Institut for Fysisk Oceanografi, Report No. 2, Copenhagen.

237. Oceanology No. 1 (1971). National Scientific Committee on Oceanic Research of the Polish Academy of Sciences, 108 p.

Contains a review article on radiative transfer in the ocean by Jerzy Dera (in Polish), as well as the paper, "Irradiance in the Euphotic Zone of the Sea," by Jerzy Dera (in English).

238. Oceanology No. 2 (1973). National Scientific Committee on Oceanic Research of the Polish Academy of Sciences, 243 p.

An analysis of underwater visibility conditions in the sea, based on the examples of the Gulf of Gdansk by J. Olszewski (in Polish with English summmary).

239. Ochakovskiy, Yu. Ye. and A. S. Suslyayev (1968). Trials of Hydro-optical Instruments in the Golfo de California. Acad. Sci. USSR, Oceanology (8:6), 872-874. (English translation).

Sea trials of instruments designed to measure photosynthetically active radiation in the sea were carried out from 4-18 May 1968 in the Golfo de California. These trials were made in accordance with the program of SCOR-UNESCO Working Group No. 15. The members of the Working Group and their assistants took part in the voyage, namely, G. Jitts and D. Lockwood (Australia), K. Nygard and G. Kullenberg (Denmark), Yu. Ochakovskiy and A. Suslyayev (USSR), J. Tyler and R. Smith (USA), A. Ivanov and M. Bauer (France). The expedition was led by the Chairman of the Working Group, J. Tyler. The Mexican hydrobiologist A. Ramiros took part in the voyage as a guest.

240. Ogura, Norio (1965). Ultra-violet Absorbance of Sea Waters of Tokyo Bay, Sagami Bay and Off-shore Waters in the Western Pacific. J. Oceanog. Soc. Japan (21), 237-244, (In Japanese).

U-V absorbance of waters of Tokyo Bay, Sagami Bay and off-shore waters in the Western North Pacific was examined with a 1 cm cell with reference to distilled water.

241. Opalski, M. A. (1963). A Summary of Observations of Underwater Visibility Available at the Oceanographic Office. U. S. Naval Oceanographic Office, Marine Sciences Department, Informal Manuscript Report 0-47-63, 8 p.

242. Optics of the Sea (Interface and In-Water Transmission and Imaging) (1973). AGARD Lecture Series #61 (AGARD-LS-61) North Atlantic Treaty Organization, about 400 p.

About two-thirds of this monograph is devoted to the activities of an American company interested in underwater imagery. Seven additional papers are devoted to theory and experimental results relating to various aspects of optical oceanography.

243. Oser, R. K., J. L. Berger, and Louis J. Franc (1967). Oceanographic Data Report San Clemente Island Area Oct. to Dec. 1966. Naval Oceanographic Office, Washington, D.C. Report No. IR 67-77, Sept., 152 p.

Includes Alpha values, visibility, ranges, and discussion of beam transmission data using NOTS null balance transmissometer.

244. Oster, R. H. and G. L. Clarke (1935). The Penetration of the Red, Green and Violet Components of Daylight into the Atlantic Waters. J. Opt. Soc. Amer. (25:3), March, 84-91.

The observations reported in this paper were made from the Atlantis and the Asterias. Three regions characterized by distinct types of ambient water were investigated: the Sargasso Sea, the Gulf of Maine, and the coastal areas near Woods Hole, Mass.

245. Otto, L. (1966). Light Attenuation in the North Sea and the Dutch Wadden Sea in Relation to Secchi Disc Visibility and Suspended Matter. Netherlands J. Sea Res. 3(1), 28-51.

246. Otto, L. (1967). Investigations on Optical properties and water-masses of the Southern North Sea. Netherlands J. Sea Res. (3:4), 532-552, December.

The use of some optical properties for the characterization of water masses in the southern North Sea is discussed. These properties are the natural fluorescence of sea water and the attenuation coefficient of red light, as well as the difference between the attenuation coefficients of blue and red light.

247. Pak, Hasong (1969). The Columbia River as a Source of Marine Light Scattering Particles. Ph.D. Dissertation, Oregon State University, July.

The Columbia River plume region was investigated by light scattering measurements and standard hydrographic station observations. The plume was traced by the light scattering particles of the plume water. The light scattering particles are estimated to be contained in the plume water for 30 to 50 days. On the basis of the data, a conceptual model was made to describe the flow of river originated particles to the ocean water.

248. Pak, H. (1974). Secchi Data of Oregon State Univ. Cruises 1968-1971.

Unpublished Secchi data from Oregon area.

249. Pak, H. and J. R. V. Zaneveld (1977). Bottom Nepheloid Layers and Bottom Mixed Layers Observed on the Continental Shelf Off Oregon. J. Geophys. Res. (82:27), 3921-3931.

This report contains results of one-hundred and seventy pairs of temperature and light transmission profiles obtained by simultaneous conductivity-temperature-depth and light transmissometer casts in three cruises on the R/V YAQUINA over the Continental Shelf off Oregon.

250. Pak, H. and J. R. V. Zaneveld (1978). Intermediate Nepheloid Layers Observed Over the Continental Margins Off Oregon. SPIE, v. 160, Ocean Optics V, 9-17.

Conclusions of beam attenuation data collected off Oregon, August 1974 though May 1975. Instrument used was a OSU transmissometer (660 nm).

251. Paramonov, A. N. (1965). The Distribution Pattern of Suspended Matter in the Black Sea: Some measurements results. Tr. Inst. Okeanol., Akad. Nauk SSSR, (Moscow State Univ.); Distribution pattern of suspended matter in the Black Sea: Some measurements results. Oceanology, Washington, D. C., S.(1):61-67; 1965, Pub. Feb. 1966, Figure., Refs. Transl. of Nekotorye rezul taty izmereniia kharaktera rasperedeleniia vzvefi v Chernom more in Okeanologiia, Moscow (5:1), 89-93.

DLC-some of the many ways in which data on the distribution of suspended matter can be used in solving many oceanological problems are mentioned in numerous papers listed in the references are referred to. The direct and indirect methods of measuring suspended matter proved generally unsuitable in the Black Sea because of the rapid precipitation of sulfur which formed by oxidation of H.S. The principal obstacle in the use of the photometric method was removed by the development of an impulse photometer-transparometer at Moscow University.

252. Paramonov, A. N., G. G. Neuymin, and V. V. Efimov (1966). Investigations in the Southwestern Part of the Norwegian Sea and the Northeastern Part of the Atlantic Ocean. Naukova Dumka, Kiev [In Russian].

253. Patsifiki Vedernikov, V. L., O. I. Koblentz-Mishke, I. N. Sukhanova, G. S. Karabashev, and Ya. Fisher (1975). A Comparison of Vertical Variations in the Suspended Matter, Chlorophyll, Photoplankton and Pigment Luminescence Intensity in the Equatorial and Peruvian Regions of the Eastern Pacific. Proceedings of the P. P. Shirshov Institute of Oceanography (Pelagic Ecosystems of the Pacific Ocean), Ed: M. E. Vinogradov, (102), 165-174.

A positive relationship was found to exist between the contents in water of suspended matter and chlorophyll as well as between these parameters and the intensity of pigment luminescence. The chlorophyll-suspended matter ratio was higher in the discontinuity layer than in the mixed upper layer. An increase with depth of the chlorophyll-phytoplankton carbon ratio in the equatorial region is accounted for by unfavorable light conditions in the discontinuity layer.

254. Pavlov, V. M. (1961). Optical Parameters of the Principal Water Masses in the North of the Indian Ocean. Okeanolog. issl. 1.

255. Pepita, T. S., M. I. Satina, and Ye. P. Delado (1960). Vertical Zooplankton Distribution in the Black Sea in Relation to Hydrological Conditions. DOKL. Akad. Nauk SSSR (133:4).

256. Petzold, Theodore J. (1977). Volume Scattering Functions for Selected Ocean Waters. Light in the Sea, John E. Tyler (ed.), 152-174.

A low angle scattering meter was used to determine the volume scattering function for small angles and a general angle scattering meter was used to determine volume scattering function between O=10° in the forward direction and O=170° in the backward direction. Data were obtained from Tongue of the Ocean, Bahama Islands, Offshore southern California, and San Diego harbor, Calif.

257. Pickard, G. L. and L. F. Giovando (1960). Some Observations of Turbidity in British Columbia Inlets. Liminol. and Oceanog. (5), 162-170.

Measurements were made by a light scattering method of the optical turbidity of the waters in some typical British Columbia inlets with depths to 700 m. The optical turbidity here used is the extinction coefficient or fractional reduction in light intensity per meter due to scattering.

258. Pinsak, A. P. (1967). Water Transparency in Lake Erie. United States Lake Survey, Detroit, Michigan, Miscellaneous paper MP-68-3, 14, In: Proceedings of the Conference on Great Lakes Research (10th), Detroit, Mich., 309-321.

Water transparency as measured with an in situ turbidity meter is consistently low in the western basin of Lake Erie because of influence of tributaries and shallow mud bottom which is easily agitated by surface waves. Changes in geographic position of high clarity water masses within the central and eastern basins are influenced predominantly by wind effect on the lake which is strong enough to mask or distort turbidity patterns normally expected from tributary influx. A general 50% increase in suspended material from summer to winter can be attributed to movement of water from the western part of the lake, seasonal increase in organic material, turbulent storm effect, and vertical circulation of the entire water column as the thermocline lowers and disappears. A direct correlation exists between temperature structure and transparency profiles with least transparency below the thermocline and near the sediment-water interface during periods of stratification. Microstratification persists in the hypolimnion and is much more detailed and complex than conventionally depicted thermal stratification.

259. Pivevarov, A. A., E. P. Anisimova, and N. Erikova (1965). Diurnal Course of the Albedo and of Solar Radiation Penetrating the Sea. Isv. Acad. Sci. USSR, Atmos. and Oceanic. Phys. Ser. (1:11), 1216-1219.

Measurements of total and reflected solar radiation flux were made in the Black Sea. The detectors used were thermoelectric pyranometers mounted on the side of a ship 3 meters above the water surface, and an automatic three-part SG galvanometer.

260. Plass, Gilbert N. and George W. Kattawar (1969). Radiative Transfer in an Atmosphere-Ocean System. Appl. Optics (8:2), 455-466.

261. Plass, Giblert N., George W. Kattawar, and John A. Guinn, Jr. (1976). Radiance Distribution Over a Ruffled Sea: Contributions from Glitter, Sky, and Ocean. Applied Optics (15:12), December, 3161-3165.

The upward radiance just above the ocean surface and at the top of the atmosphere is calculated for a realistic model including an ocean surface with waves. The separate contributions of the sun glitter, the reflected sky radiance, and the upwelling photons from the ocean are calculated. The Monte Carlo method takes account of both Rayleigh scattering by the molecules and Mie scattering by the aerosols as well as molecular and aerosol absorption in the atmosphere. Similarly, in the ocean, both Rayleigh scattering by the water molecules and Mie scattering by the hydrosols as well as absorption by the water molecules and hydrosols are considered. Separate single-scattering functions are used for the aerosols and hydrosols calculated from the Mie theory.

262. Polcyn, F. C. and D. R. Lyzenga (1973). Multispectral Sensing of Water Parameters-Temperature, Turbidity, Chlorophyll and Color. In: Remote Sensing and Water Resources Management, Proceedings of the Symposium, Burlington, Ontario, Canada, June 11-14, American Water Resources Association, 394-403.

With the development of the multispectral scanner, improved techniques for mapping temperature gradients, turbidity, water color, and algal concentrations over large areas have been demonstrated. A remote calculation of water depth is shown to be possible, where the lake water transparency is sufficiently clear to detect light reflections from the lake floor. Depths to 20 feet have been measured in the nearshore zone of Lake Michigan and near the Little Bahama Bank. Maps showing relative chlorophyll concentrations have been made for some parts of the shoreline areas near Port Sheldon, Michigan. Spectral characteristics related to chloroplyll concentrations were investigated for test samples across the thermal bar taken during the spring formation of the bar.

263. Postma, Von H. and K. Kalle (1955). Die enstehung von trubungszonen im unterlauf der flusse speziell im hinblick auf der verhaltnisse in der unter Elbe. D. Hydr. Ztschr. (8), 137-144.

Turbidity measurements in water taken from various places in the lower Elbe help dispel the view that the occurrence of turbid zones is due to dissolved colloids and that dynamic processes play only a subordinate part in the development of such turbid zones. The peculiar water movement in such tidal estuaries form a sort of "trap for suspended matter." The turbid matter from river water is caught in the mixing zones and makes them revolve continuously in a vertical circulation, while the water itself flows to the sea without hindrance. The chemical process of precipitation seems to exercise only a slight influence on the development of the turbid zones.

264. Postma, H. (1961). Suspended Matter and Secchi Disc Visibility in Coastal Waters. Netherlands J. Sea Res. (1:3), 359-390.

From experiments in the laboratory with artificially prepared sand and clay suspensions a simple equation could be derived, which gives the quantitative relation between visibility range, determined by means of a Secchi disc, and the amounts and the grainsizes of the suspended materials. This relation, however, cannot directly be applied to natural waters, because in the latter nearly always an important part of the suspended matter is organic. It could be shown that a certain amount of organic matter intercepts the light more effectively than the same amount of inorganic matter, not only if particle sizes are equal, but also if the settling velocities are the same, although in the latter case organic particles are considerably larger than inorganic ones.

265. Potts, John (1971). Optical Signatures of the Nearshore Waters of Southern Monterey Bay. M.S. Thesis, Naval Postgraduate School, Monterey, Calif., December.

266. Powell, Wilson M. and George L. Clarke (1936). The Reflection and Absorption of Daylight at the Surface of the Ocean. J. Opt. Soc. Am. (26), March, 111-200.

Includes measurements made with violet and red sensitive photometers in Buzzards Bay and Vineyard Sound, and curves of relation between depth and irradiation expressed as a percentage of light just over the surface measured with a green sensitive photometer at Buzzards Bay and a violet sensitive photometer at Georges Bank.

267. Powers, C. F., E. E. Deulber, Jr., and R. H. Backus (1952). The Transparency by Black and White Secchi Disk of the Waters of New York and Newport Bights, Cruise Stirni I, July-Sept., 1951. Status Rept. No. 15, 12 p. Cornell University, Ithaca, N.Y.

Transparency in feet was observed over black and white Secchi disks at 228 stations in the waters of the New York Bight and Newport Bight areas.

268. Preisendorfer, R. W. (1976). Hydrologic Optics. U. S. Govt. Print. Off., order no. C55.602:H99, Washington, D.C.

A mathematical treatment of radiative transfer in ocean or lake water. Six volumes.

269. Prettyman, C. E. and W. G. Swarner (1968). Investigating Optical Properties of the Sea Relevant to Subsurface Target Detection Using ORAD Systems, Vol. I, Optical Radar Ranging from Submerged Targets in the Gulf of Mexico. Ohio State Univ. Columbus, Electroscience Lab, Report No. 2413-2, Sept., 77 p.

The results of optical ranging experiments performed by O.S.U. Electro-Science Laboratory personnel at the U. S. Navy Mine Defense Laboratory Stage I Facility in the Gulf of Mexico during the summer of 1966 are presented. Ranging was performed from subsurface targets at various angles of incidence with respect to the sea surface, and as a function of various system and sea parameters using the O.S.U. second-harmonic neodymium-laser optical radar mounted 60 ft above the ocean surface.

270. Prettyman, C. E. and M. O. Cermak (1969). Time Variations of the Rough Ocean Surface and Its Effect on an Incident Laser Beam. Electroscience Lab., Dept. of Elect. Engineering, Ohio State Univ., Columbus, IEEE Trans. on Geoscience Electronics, GE-7(4), October, 235-240.

Results of experiments performed in the Gulf of Mexico. A study of the time variations of sea surface slope by the distribution of light on a submerged screen from a small incident laser beam is summarized.

271. Ramsey, Richard C. (1968). Study of the Remote Measurement of Ocean Color. TRW Report, prepared under Contract NASW-1658. Prepared for NASA HQ, Washington, D.C. by TRW Systems Corp.

An evalulation is given of the factors which affect remote measurements of ocean color. The results are used to define a set of requirements for a system to make ocean color measurements from a spacecraft. The effects of atmosphere, sun, ocean surface, and ocean contents on these measurements are evaluated. Calculations of upward flux through the atmosphere from ocean waters containing various amounts of chlorophyll are used to define system requirements. A preliminary design of a sensor, utilizing the WISP concept of TRW Systems, is provided with the capability of distinguishing between zero and 0.2 mg/m^3 of chlorophyll in ocean waters. This design requires the measurement of upward flux in fifteen spectral bands with a ground resolution of 2500 feet and yields total ocean coverage in 14 days from a 287 nautical mile sun-synchronous orbit.

272. Ray, I. A. and K. Bondar (1967). Turbidity, Transparency and Color of Water in Estuary Area. Naval Oceanographic Office, Washington, D.C., Report No. NOO-TRANS-258, 13 p.

The data used for this study was obtained from observations conducted by various organizations of the U.S.S.R. and Rumania on the distribution of turbidity, transparency, and color of water in the Danube Estuary.

273. Reinhardt, George W. (1968). Optical Attenuation by Natural Waters. Ohio State Univ. Electroscience Lab., Tech. Report 2413-1, 69 p. (NADC Contract No. N62269-67-G0416).

Optical attenuation data for several clear lakes, Florida spring water, Key West Harbor, and Gulf Stream, and measurements of total attenuation coefficient vs. wavelength, time and depth at the U.S.N. Mine Defense Lab. Stage I tower in the Gulf of Mexico near Panama City, Florida.

274. Riley, G. A. (1956). Oceanography of Long Island Sound, 1952-1954, II. Physical Oceanography. Bull. Bingham Oceanography Collection (15), 15-46.

Temperature and salinity data were obtained at eight stations in the central part of the Sound at weekly intervals from March 1952 to March 1954. Seasonal trends and differences from one year to the next are discussed in relation to Weather Bureau data on air temperature and precipitation. Data on radiation and water transparency are presented, and the latter are analyzed with respect to phytoplankton, winds, currents and other factors that affect transparency in shallow coastal waters.

275. Rokuro, Adachi (1972). A Taxonomical Study of the Red Tide Organisms. J. Fac. Fish., Mie Pref. University (9:11), 9-145.

The species composition of the red tide organisms, which appear frequently along the coast of Japan, were analyzed to determine the dominant species and to describe their taxonomy. A large number of samples (121) were collected from all over Japan from 1964 to 1970. They were diverse taxonomically and cover eight classes of organisms. Among them, the Dinophyceae represent the most frequently appearing species. At the time of sampling, the data on the duration of appearance, color of the sea area, temperature, chlorinity and dissolved oxygen of the water, and the fishery damage were obtained. The red tide samples were classified according to their species composition into two types, the simple-phase and complex-phase samples. The former represent samples in which the dominant species occupied more than 95% of the cells by number and the latter, those in which the dominant species amounted to less than 95%. There are 97 simple-phase samples and 43 complex-phase ones. A total of 41 species were regarded as the important red tide organisms.

276. Ruhlmann, H. K. (1967). Optical Transmission Data Measured During Cruise Number 1 of Project EARS. Navy Underwater Sound Laboratory, New London, Conn., Rept. No. USL-TM-2122-81-67.

Plots of percent transmission for a four meter path versus depth are presented. The data points are at one minute intervals. The measurements were made from a minimum depth of 4 m below the surface to 3 m from the

ocean floor. The instrument used for these measurements was a 4 m optical transmissometer which measures transmission of light in the 5000-6000A wavelength region. The system was lowered on a cable from the USNS SANDS for the measurements.

277. Ruhlmann, H. K. and L. J. Tree (1968). Deep Sea Optical Transmissometer. Soc. of Photo-optical Instru. Engineer., Underwater Photo-Opt. Instrumentation Application. Seminar Proc. (12), 107-113.

This paper describes the design, construction and calibration of a deep sea transmissometer and data obtained in the North Atlantic Ocean to depths of 5100 meters.

278. Rutkovskaya, V. A. and B. V. Konovalov (1972). Some Results of the Actinometric Measurements in the Pacific Waters. In: Optics of the Ocean and Atmosphere, Shifrin, K. S. (ed.), Acadamy of Sciences USSR Institute of Oceanology. Publishing House Nauka, Leningrad, 193-198.

Results of the aclinometric measurements in the Pacific waters. The result of the solar energy measurement in the central Pacific waters by means of the underwater peranometer are discussed. The method of the approximate calculation of the total solar energy per day in different depths is proposed.

279. Russell, H. D. and G. L. Clarke (1944). The transparency of East Indian Waters and Adjacent Areas. Woods Hole Oceanographic Institution, Woods Hole, Mass., WHOI-44-18, 25 p.

280. Ryther, J. H. and C. S. Yentsch (1957). The Estimation of Phytoplankton Production in the Ocean from Chlorophyll and Light Data. Limnol. and Oceanog. (2:3), 281-286.

The relationship was determined between photosynthetic rate at light saturation and chlorophyll content in natural populations and cultures of marine phytoplankton. A mean value of 3.7g C assimilated/hour/g chlorophyll was obtained from experimental results and from data present in the literature. A method is described by means of which organic production beneath a unit of sea surface may be estimated from the chlorophyll content of the water, the total daily solar radiation reaching the sea surface, and the extinction coefficient of visible light in the water column. Production values calculated by this method are compared with values obtained by in situ productivity measurements.

281. Saloman, C. H. (1974). Physical, Chemical, and Biological Characteristics of Nearshore Zone of Sand Key, Florida, Prior to Beach Restoration, v. 1. National Marine Fisheries Service, Panama City, Florida, June.

Includes Secchi data collected in Florida area, November 1970 through September 1971.

282. Saloman, C. H. and L. A. Collins (1974). NOAA NMFS DR90, NOAA 74111312, Hydrographic Observations in Tampa Bay and Adjacent Waters 1972. National Fisheries Service, Seattle, Wash., 181 p.

Secchi data collected in Tampa Bay, Florida, January 1971 through December 1972.

283. Sasaki, T., N. Okami, E. Watanabe, and G. Oshiba (1955). Optical Properties of the Water in the Kuroshio Current. Records Oceanog. Works Japan (2:2), 1-8, October.

> Transmissions for natural light in a region of the Kuroshio Current (Japan Current) east of the Izu peninsula were measured for red, yellow, green, blue violet lights by means of an underwater photometer with photomultiplier. Filters used were Kaken monochromatic filters having narrow ranges of transmission of about 1000 A°. Measurements were made off Shimoda Port, in the Kuroshio Current between the Oshima and Izu peninsulas, and 0.5 miles off Citami and Ajiro.

284. Sasaki, T., N. Okami, S. Watanabe, and G. Oshiba (1957). Measurements of the Angular Distribution of Daylight in the Sea. Records Oceanog. Works Japan, Special Number (March 1957), 42-45.

> Optical measurements in Hunka Bay, 11 miles off Muroran.

285. Sasaki, T., N. Okami, G. Oshiba, and S. Watanabe (1962). Studies on Suspended Particles in Deep Sea Water. Sci. Paper. Inst. Phys. Chem. Res. (Tokyo), (56), 77-83.

> A photometer for measuring the angular distribution of light was used to examine suspended particles sampled in the Japan Trench.

286. Sasaki, Tadayoshi, Naboro Okami, and Setsuki Matsumura (1968). Scattering Functions for Deep Sea Water of the Kuroshio La Mer. Bul. de lu Societe Franco - Japanaise d'Oceanographic, (6:3).

> Measurement was made between 30° and 150° of the scattering angle by a light-scattering photometer of deep sea water sampled in the Kuroshio region.

287. Sasaki, T. and N. Okami (1968). Optical Properties of the Water in Adjacent Regions of the Kuroshio. J. Oceanogr. Soc. Jap. (24:2), 45-50, April.

> Measurements of the irradiance and scalar irradiance were made using an underwater scalar irradiance meter at Sagami Bay and the East China Sea, adjacent regions of the Kuroshio. The values of the volume absorption function, reflectance function and diffuse attenuation function for scalar irradiance and irradiance were calculated.

288. Sasaki, Tadayoshi, Gohachiro Oshiba, and Motoaki Kishino (1966). A 4 π Underwater Irradiance Meter. J. Oceanogr. Soc. Jap. (22:4), August.

> Includes results of underwater irradiance measurements at 30 to 100 m depths off the coast of Ito City, Shizvoka Prefecture.

289. Schenek, H. Jr., J. Van Ryzin, and W. Lamb (1971). Turbidity Temperature Profiles in the Narragansett Bay Area. J. Opt. Soc. Amer. (61:6), 831-832.

> During the 1970 summer, a number of stations were established in the Narragansett Bay area at which simultaneous beam attenuation, temperature and depth readings were made in conjunction with a series of scuba-diver

visibility studies. A cloud of turbid water was always found below the thermocline. It was found that the definition of the turbidity cloud region improves as the slope of the thermocline increases.

290. Schubel, J. R. (1969). Size Distribution of the Suspended Particles of the Chesapeake Bay Turbidity Maximum. Netherlands J. Sea Res. (4:3), 283-309, August.

Turbidity measurements in the Chesapeake Bay.

291. Scruton, P. C. and D. G. Moore (1953). Distribution of Surface Turbidity Off the Mississippi Delta. Bull. Amer. Assoc. Pet. Geol. (37), 1067-1074.

292. Shannon, J. G. (1975). Correlation of Beam and Diffuse Attenuation Coefficients Measured in Selected Ocean Waters. Proceedings of the Society of Photo-Optical Instrumentation Engineers, Ocean Optics (64), 3-11.

293. Shannon, J. G. (1978). An Analysis of the Utility of Airborne Electro-optical Bathymetry Systems in a Sample Foreign Coastal Region. Draft, Naval Air Development Center, Warminster, Penn. (C).

In order to test the utility of the HALS and MSS systems for bathymetric determination, a coastal area in the West Coast of Africa was selected and optical measurements ($\bar{k}$) tested for operational performance.

294. Shepard, Arthur B. (1970). A Comparison of Oceanic Parameters During Upwelling Off the Central Coast of California. M.S. Thesis, Naval Postgraduate School, Monterey, Calif., Sept. 1970, 217.

Oceanic parameters, including beam transmission of light, were observed at eighty-five stations from the surface to 100 meter depth in the region between Monterey Bay and San Francisco Bay.

295. Sherstyankin, P. P. (1972). Scanning in Measurements of Angular Brightness Distribution Under Water. In: Sb. MOVSK. Gidrofiz. Issled. (1:64), Sevastopol', 1974, 142-150. (R.Zh.F., 12/74, no. 12A261).

A general description is given of a scanninng system for studying the spatial distribution of optical brightness under water. Practical realization of variants of this system suggests the possibility of developing simple and reliable light meters with high information content, for measuring angular distribution of optical brightness in oceans and other bodies of water.

296. Shifrin, K. S. and V. N. Pelevich (1975). Tasks and Principal Results of Studies of the Light Field in the Waters of the Indian Ocean. Gidrofiz. i Opticheskiye Iss/Edovaniya Indiyskom Okeane, Moskva, FSL20984, 100-103.

297. Shifrin, K. S. (ed.) (1975). Optics of the Ocean and the Atmosphere. Publishing House Nauka, Leningrad, 231 p. (In Russian with English summaries.)

Contains original scientific papers by many of the outstanding scientists in this field. Emphasizes theory and measurement properties with some applications to other fields.

298. Small, L. F. (1980). Irradiance Attenuation Data Collected Off Oregon 1962-1965. Unpublished Report-Personnel Communication, Oregon State Univ.

Instrument used was a Kahl scientific irradiance meter.

299. Small, Lawrence F. and Herbert Curl, Jr. (1968). The Relative Contribution of Particulate Chlorophyll and River Triptan to the Extinction of Light Off the Coast of Oregon. Limnol. and Oceanog. (13:1), June, 84-91.

Extinction coefficients and chlorophyll-a concentrations were measured for three years along sampling lines off the mouth of a large river (Columbia), a relatively small river (Yaquina), and a section of Oregon coastline with little river outflow. The relative contribution of particulate chlorophyll and nonliving suspended matter to the extinction coefficient, k, was assessed using a three-component equation that allowed the separation of areas and seasons in which k was a function of chlorophyll concentration from areas and seasons in which other factors besides chlorophyll concentration were involved.

300. Smith, Raymond C. and John E. Tyler (1968). Spectral Irradiance Data Obtained During WC-15 Sea Trials in the Gulf of California, May 5 to 16, 1968. Scripps Institution of Oceanography, Ref. No. 68-29, August.

301. Smith, Raymond C. and Wayne H. Wilson, Jr. (1972). Photon Scalar Irradiance. Applied Optics 11(4), 934-938.

Photon scalar irradiance h is defined as the total number of photons per unit time and area arriving at a point from all directions about the point when all directions are weighted evenly. Reasons for considering photon scalar irradiance an optimum measure of radiant energy available for photo-synthesis are briefly reviewed. A new technique for the measurement of h and considerations for calibrating an underwater photon scalar irradiance collector on an absolute basis are outlined.

302. Smith, Raymond C. and Karen S. Baker (1978). The Bio-Optical State of Ocean Waters and Remote Sensing. Limnol. and Oceanog. (23:2), 247-259.

The data used in this report was obtained on several cruises (Fresnel I and II, Discoverer Expedition). It includes complete spectral irradiance measurements made with the Scripps spectroradiometer. Locations are: the Gulf of California, Sargasso Sea, Gulf of Mexico, central eastern Pacific, the gyre-like circulation of the north central Pacific water mass, and both the North and South Pacific central water masses.

303. Smith, R. C. and Karen S. Baker (1978). Optical Classification of Natural Waters. Limnol. and Oceanog. (23:2), March, 260-267.

A technique has been developed that leads to an optical classification of natural waters in terms of the dissolved and suspended biogenous material present. As a first approximation, this classification has been made in terms of the total chlorophyll-like pigment concentration. A relationship between the spectral diffuse attenuation coefficient for irradiance and the chlorophyll-like pigment concentration has been found with spectral

irradiance data from diverse types of ocean waters. The specific spectral attenuation coefficient due to phytoplankton is shown to be consistent with laboratory measurements of the diffuse absorption coefficient of various lot cultures of phytoplankton. The data used for this analysis is from: Tyler and Smith, 1970, Discoverer Expedition 1973: SIO Ref 73-16, Morel and Prieur, 1975.

304. Soluri, E. A. (1971). A Comparison of Oceanic Parameters During the Oceanic Period Off the Central Coast of California. M.S. Thesis, Naval Postgraduate School, Monterey, Calif., March, 369 p.

A detailed examination of the coastal region between Monterey Bay and San Francisco Bay was conducted from 1 to 6 November 1970. Measurements of temperature, salinity, sound velocity, beam transmittance, Coulter particle size distribution, chlorophyll-a, phosphate, and oxygen were obtained from the surface to 100 meters at 86 stations. The data collected are presented in the form of contours in horizontal and vertical sections and depth profile.

305. Sorokina, N. A., G. G. Neuymin, A. I. Yermolenko, and R. K. Timokhina (1974). Objective Analysis of the Transparency Field in the Tropical Atlantic. Trudy Morsk. Gidrofiz. Instituta (2:65), 65-71 (Akademia Nauk USSR, Marine Hydrophysical Institute).

The distribution of the incident-light extinction coefficient at the 10-m level in the tropical Atlantic was mapped by objective analysis. The map corresponds to the distribution of zones of water convergence and divergence and to the distribution of zones of biologically productive water. A chart is given for the Central Atlantic for the region between about 20°N to 20°S showing measurements of the incident light extinction coefficient for an effective wavelength of 530 nm at 115 stations taken on the 10th, 24th, 26th, and 27th voyages of the R/V MIKHAIL LOMONOSOV in arbitrary units. The data are not contoured but are presented numerically for each 2-degree square in the region.

306. Sorokina, N. A. (1975). A Transparency Field for Some Levels in the Tropical Atlantic. Morsk. Gidrofiz. Issledovaiya, Morskoy Gidrofizicheskiy Institut, AN USSR (Sevastopol), (4:71), 112-117.

The possibility of application of objective analysis methods to construction of charts of index of directed light attenuation in the tropical Atlantic is shown in the paper. The charts of distribution of attenuation index which were obtained, as far as we know, for the first time characterize the hydrooptical structure of the region under investigation, the information on which is necesary for a number of practical problems.

307. Spilhaus, A. F., Jr. (1965). Observations of Light Scattering in Sea Water. Ph.D. Thesis, Dept. of Geology and Geophysics, Massachusetts Institute of Technology, February.

A method was devised to measure in situ the ratio of the volume scattering function at 20° to that at 45° and 135°. The results of this experiment led to a study of the shape of the volume scattering function for various types of sea water. This study was made using a standard laboratory

device on shipboard. Samples were both pumped aboard from surface waters and taken at depths up to 2000 m by Nansen bottles. Four hundred samples were taken in a region between Woods Hole and 26°N, 63°W. Using a laser as the light source, forward scattering measurements were made to obtain relative total scattering. A continuous track was made between Woods Hole and Port Lewis, Mauritius. In the proximity of land twofold fluctuations of the scattering in a range approximately three times higher than the nearly constant values found in mid-Atlantic were observed. Some fluctuations of the open sea values in the Atlantic were associated with thermal changes.

308. Spilhaus, A. F., Jr. and W. S. von Arx (1966). Measurements of the Forward Scattering of a Laser Beam in Sea Water. Deep Sea Research (13), 755-759.

Using a laser as the light source, forward scattering measurements were made continuously to obtain relative total scattering along a track between Woods Hole and Port Lewis, Mauritius. The base value of the scattering magnitude was found to be different for different bodies of water. Wide fluctuations of scattering occurred near land, but little variation was found in the open sea except in the presence of sharp surface temperature gradients.

309. Spilhaus, A. F., Jr. (1968). Observations of Light Scattering in Seawater. Limnol. and Oceanog. (13), 418-422.

A study of the variability of the volume scattering function of some water types was made on samples taken from the surface and at depth in the Sargasso Sea, and in a thermal front South of Bermuda.

310. Stamm, Gordon L. and Robert A. Langel (1961). Some Spectral Irradiance Measurements of Upwelling Natural Light Off the East Coast of the United States. J. Opt. Soc. Amer. (51:10), October, 1090-1094.

Spectra of upwelling light were photographed from an aircraft at various places over the sea off the eastern coast of the United States. Subsequent calibration of the spectroscopic plates resulted in data which gave spectral irradiances on the underside of a flat, horizontal surface over the water. Curves of spectral irradiances were drawn for various locations and for different sea and atmospheric conditions.

311. Stamm, G. L., C. F. Wingquist, et al. (1966). Airborne Searchlight Signals Measured Underwater in the Chesapeake Bay. NRL Report 6376, January 25.

312. Steemann, Nielsen E. (1975). Marine Photosynthesis. Elsevier Oceanography Series 13, Elsevier Publishing Co., New York.

Discusses the problem of measuring the light available for photosynthesis, the units to be used, and the rate of photosynthesis as a function of the measured irradiance.

313. Stentz, D. A. (1975). A Chronological Study of the Measurement of the Optical Properties of Ocean Waters, and an Atlas of the Diffuse Attenuation Coefficient, k, of Tropical Atlantic Ocean Waters. M.S. Thesis, Naval Postgraduate School, Monterey, Calif., 75 p.

314. Stevenson, W. H. and E. J. Pastula (1973). Investigation Using Data from ERTS-1 to Develop and Implement Utilization of Living Marine Resources. Final Report, 1 July 1972-4 October 1973, National Marine Fisheries Service, Bay St. Louis, Mississippi, 198 p.

Secchi data collected in August 1972 in the Mississippi Sound.

315. Stromer, Peter R. (1963). Wind Waves and Sea Slope Measurements. An Annotated Bibliography. Lockheed Missiles and Space Co., Sunnyvale, Calif., Rept. No. (6-90-63-78, SRB64-4), 61 p.

This bibliography cites 134 references on the related subject of wind waves and sea slope measurement. Oceanographic measurements reported in bibliography have emphasized optical techniques and light transmission in sea water. The period of literature coverage is from 1948 through June 1963.

316. Stroup, E. D. and Judith Wood (1966). Atlas of the Distribution of Turbidity, Phosphate, and Chlorophyll in Chesapeake Bay 1949-1951. Chesapeake Bay Inst., Johns Hopkins Univ., Annapolis, Md., Geographical Summary Rept. No. 4, 193 p.

317. Sugihara, S. (1969). The Color of the Sea in the Sound Between Denmark and Sweden Studied with a New Colorimeter. Kobenhavns Universitet Institut Fysisk Oceanografi, Report No. 8, Copenhagen.

318. Sysoev, N. N. (1969). Oceanographic Research by the "Vityaz" in the N. Pacific Under the IGY Programme. NSF Trans. TT-68-50358.

Some transparency measurements.

319. Texas Natural Resources Information Systems. Secchi data from 1968-77 was collected in Texas coastal waters. A total of 14,232 data observations are stored on magnetic tape.

320. Thorndike, E. M. and Maurice Ewing (1967). Light Scattering in the Sea, Lamont-Doherty Geological Observatory, Palisades, N.Y., CONTRIB-965. Soc. Photo-opt. Instr. En., Underwater Photo Optics Seminar P1-7 1966.

Nephelometers for making *in situ* measurements of light scattering at all depths from the surface to the bottom of the ocean are described. Preliminary results in the Atlantic, Pacific, and Arctic Oceans and in the Bering and Caribbean Seas are summarized. The materials present in sea water can be divided roughly into three parts on the basis of particle size: objects that are much larger than the wavelength of light and so can be imaged and studied in detail visually or with underwater cameras. Suspended particles with sizes within a few orders of magnitude of the wavelength of light, whose presence can be detected by the light that they scatter. Materials that are dissolved in sea water and can be investigated by the modifications in the absorption or refractive index that they produce.

321. Timofeyva, V. A. (1960). Instrument for Determining the Attenuation Coefficient of Directed Light in the Sea. Sov. Oceanog. 1962 Ser., 4, 79-83.

The present article describes a transparency meter constructed in 1954 at Black Sea Branch of the Marine Hydrophysical Institute and tested in Nov-Dec 1957 on the R/V MIKHAIL LOMONOSOV.

322. Timofeyva, V. A. (1962). Spatial Distribution of the Degree of Polarization of Natural Light in the Ocean. Bull. (Izv.) Acad. Sci. USSR, Geophysical Series, 6(12) 1160-1164.

323. Timofeyva, V. A. and G. G. Neuymin (1968). Theoretical and Experimental Work on Marine Optics in the Soviet Union. Izvestiya, Atmospheric and Oceanic Physics (4:12), 1305-1323 (Eng. translation p. 747-757 in corresponding translated journal.)

The development of experimental research (both in the laboratory and in nature) of the light field in a turbid water column and its application to marine optics under condition of natural illumination are discussed in the first part of this paper (written by Timofeyeva), with special reference to the pioneering work done by the Institute of Marine Hydrophysics. Investigations carried out at sea, with a description of the apparatus used, are described in the second part of the paper (written by Neuymin).

324. Tolbert, W. H. (1959). On the Concentration and Size Distribution of Particulate Matter in Sea Water. Navy Mine Defense Lab., Panama City, Florida, Report No. TP-168, 40 p.

Using Secchi disk data, the attenuation of light was correlated with particulate content. Sea water samples were collected from St. Andrew Bay and from the Gulf of Mexico approximately one mile seaward of the harbor entrance to Panama City, Florida. Surface, mid-depth and near bottom samples were obtained.

325. Tressler, Willis L. (1961). Oceanographic Stations Taken in the Indian Ocean by USCGC EASTWIND (WAGB-279) in 1961. Naval Oceanographic Office Washington, D.C., NOO TR141, 84 p.

During late March and April 1961, the USCGC Eastwind (WAGB-279) occupied 30 oceanographic stations in the Indian Ocean. Three sections were made, one running from off Cape Leeuwin, Australia, west as far as 78°E longitude, a second continuing north from this point to 40°N latitude, and the third, which continued west to just south of Socotra Island. Measurements were made of temperature, salinity, and dissolved oxygen; and from these data density, sound velocity, and percentage of saturation of dissolved oxygen were derived. Transparency was determined by Secchi disk, and the deep scattering layer was observed.

326. Tucker, Stevens P. and James Reese (1968). In Situ Measurements of the Volume Scattering Function for Light in Sea Water. American Geophysical Union, 49th Annual Meeting (Washington, D.C., April 8-11, 1968), In: Amer. Geophys. U. Trans. (49:1), 215 p.

This paper presents the results of in situ measurements of absolute, and in some instances relative, volume scattering functions for light made during the past 2-1/2 years at the U. S. Navy Electronics Laboratory (NEL) in San Diego, California, with a modified version of the underwater light

scattering meter designed by Tyler and Austin. In situ data are given for depths ranging from the surface to 1000 meters at a number of stations in coastal waters off San Diego. In addition, a comparison is made between in situ measurements taken with the NEL scattering meter and other measurements taken in the laboratory with a Brice-Pheonix scatterometer on water samples from the in situ location. Mie scattering functions are used to interpret the observed results.

327. Tucker, Stevens P., R. D. Waer, and L. A. Yeske (1969). The Correlation of Oceanic Parameters in Monterey Bay, California. J. Opt. Soc. Amer. (59:4), 476.

An investigation of the correlation of oceanic parameters with light attenuation in Monterey Bay, California, was conducted during July and August 1968. Measurements of beam transmittance, salinity, temperature, density, and particulate matter, related in time and depth, were obtained during four cruises. Nearly 400 water samples were taken from two stations at depths between 0 and 85 m. Temperature showed the greatest correlation with beam transmittance. Isopycnals and beam-transmittance contours showed a similar good correlation. Although salinity correlations were not clearly defined, isolated salinity pockets often appeared to be associated with transmissivity perturbations. A roughly linear relationship between values of particulate count and beam transmittance was observed. Particle sizes were found to decrease with increased depths. Approximately 68% of the particles affecting beam transmittance were less than 10 μ in diameter, while approximately 96% appeared to be less than 13 μ. The greatest change in transmissivity occurred in the thermocline, since this was the region of the greatest particulate concentration. Beam-transmittance isolines generally oscillate with a tidal cycle period, the minimum values usually occurring at low tide.

328. Tucker, S. P. and P. S. Labyak (1969). Oceanographic Survey of Coastal Waters Between San Francisco and Monterey, California. Trans. Amer. Geophys. U. (50:11), 629.

A detailed oceanographic survey of the coastal waters between Monterey Bay and San Francisco Bay, California, was conducted from 10 through 18 May 1969. Measurements of beam transmittance, sound velocity, temperature, and particulate count were obtained. Some 79 oceanographic stations were occupied, and over 500 water samples were taken for particulate analysis. The optical properties of this region were found to be very complex. The waters appeared to be affected by flow from San Francisco Bay, littoral material, upwelling, and possible sewage outfalls during the survey. A greater volume of water with low transmissivity and high particle count existed in the northern region of the survey area than in the southern region. An eddy system between Monterey Bay and Point Ano Nuevo was suggested. Approximately 90 percent of the particles affecting beam transmittance were less than 12 μ in diameter. Particle sizes found to decrease with increased depths. A fairly good correlation of beam transmittance with particle count was observed except near shore areas.

329. Tucker, S. P. (1980). A Bibliography of Optical Oceanography. Oceanography Department, Naval Postgraduate School, Monterey, Calif. (unpublished).

Based on a number of sources to about 1970, including the Bibliography of the Publications on the color, transparency, and penetration of daylight into natural waters by Vranski and Markov (item No. 1243), and Jerlov's book in Optical Oceanography. So far the bibliography of Du Pre and Dawson has not been included nor has the more recent Bibliography of Underwater Photography published by Eastman Kodak Company been checked. Sources cited in the present bibliography are those which include the location of the data used for the research in the annotation.

330. Tucker, S. P. (1973). Measurements of the Absolute Volume Scattering for Green Light in Southern California Coastal Waters. Ph.D. thesis, Oregon State University, Corvallis.

331. Tucker, S. P. (1979). Hydrooptics in the Soviet Union: A Bibliography. Naval Postgraduate School, Oceanography Department, Monterey, California.

332. Tyler, John E. (1960). Radiance Distribution as a Function of Depth in an Underwater Environment. Scripps Inst. Oceanogr. Bull. (7:5), 369-386.

333. Tyler, John E. (1965). In Situ Spectroscopy in Ocean and Lake Waters. J. Opt. Soc. Amer. (55:7), July.

In situ experimental measurements over the wavelength range 400-700 nm have been made in Crater Lake and in Pacific coastal water to reveal their inherent absorption spectra. The measurements are reported as the ratio of the radiance observed in a horizontal direction underwater to the irradiance falling on the surface of the water and, as such, are independent of the spectral properties of the source of flux as well as those of the detector. The instrument used is discussed briefly and a short theoretical analysis is given to illustrate the effects of changes in absorption and scattering on the ratios obtained.

334. Tyler, John E. and R. C. Smith (1967). Spectroradiometric Characteristics of Natural Light Underwater. J. Opt. Soc. Amer. (57:5), 595-601.

This paper presents spectroradiometric data on the natural radiant flux occurring underwater at three locations in the Gulf of California, in Pacific coastal water near San Diego, and in the plankton-rich water of San Vicente Reservoir (San Diego County). Spectral radiance and irradiance have been measured, and it is shown that under certain circumstances spectral data for these two radiometric quantities are directly proportional. The data have been used to calculate spectral values of the attenuation coefficient and of the reflection function. The various spectra correlate qualitatively with apparent chlorophyll concentration and water color.

335. Tyler, John E. (1968). The Secchi Disk. Limnol. and Oceanog. (13:1).

The theory and practice of the Secchi disk experiment are discussed. It is shown, in theory, that the Secchi disk reading can be used to calculate the sum of the total and diffuse attenuation coefficients, and K. To obtain independent values of alpha and K it is necessary to make some other measurements.

336. Tyler, John E. and Raymond C. Smith (1970). Measurements of Spectral Irradiance Underwater. Gordon and Breach Science Publishers, New York, New York.

Tables and graphs of computed values of the spectral diffuse attenuation coefficients at 350 to 740 nm and graphs of spectral reflectance (350-740 nm) for Crater Lake, Gulf Stream, 10 miles west of Bimini, Tongue of the Ocean, Islas Tres Marias, Gulf of California, San Vicente Lake, San Diego.

337. Tyler, J. E., R. W. Austin, and T. J. Petzold (1974). A Beam Transmissometer for Oceanographic Measurements in Suspended Solids in Water. R. J. Gibbs (ed.), Plenum Press, New York.

338. Tyler, John E. (ed.) (1977). Light in the Sea. Benchmark Papers in Optics: Vol. 3, Dowden, Hutchinson and Ross, Inc.

339. Utterback, C. L. and J. Watson Boyle (1933). Light Penetration in the Waters Off the San Juan Archipelago. J. Opt. Soc. Amer. (23:10), October, 333-338.

Measurements of the penetration of visible solar radiation into the waters of the San Juan Archipelago have been made at several stations, and absorption coefficients computed from the measurements. The data reported include three spectral bands: One from 6000 A to 7000 A with nearly constant transmission throughout this band; the second from 5000 A to 5900 A with a definite maximum at 5400 A; and a third from 4100 A to 5000 A with a maximum at 4650 A.

340. Utterback, C. L. and W. Jorgensen (1934). Absorption of Daylight in the North Pacific Ocean. J. Cons. Intern. Expl. Mer. (9:2), 197-209.

341. Utterback, C. L. (1933). Light Penetration in the Waters of Southern Alaska. J. Opt. Soc. Amer., (23), October, 339.

Absorption coefficients for waters of Hecate Strait, Revillagigedo Channel, Sumner Strait, and off Cape Spencer for the blue-green and red portions of the spectrum. Absorption curves for Sumner Strait and off Cape Spencer.

342. Van Norden, Maxim F. (1979). The Transparency of Selected U. S. Coastal Waters with Applications to Laser Bathymetry. M. S. Thesis, U. S. Naval Postgraduate School, Monterey, Calif., September.

The operational effectiveness of airborne laser hydrography systems, considering the optical environment of the coastal waters of Oregon, Washington, and the Gulf Coast states, is examined. The best times of year are predicted for conducting laser bathymetry considering the temporal and spatial variability of optical properties due to seasonal effects, and charts of seasonally averaged optical measurements are given. Original formulas to convert beam attenuation coefficients and Secchi depth measurements to irradiance attenuation coefficients are included.

343. Vinogradov, K. E. (Chief Editor) (1975). Ecosystems of the Pelagic Zone of the Pacific Ocean. Proceedings of the P. P. Shirshov Institute of Oceanography, Acad. Sci. USSR (102), 408.

The ecosystems in the pelagic zone of the Eastern Equatorial Pacific were studied during the 17th cruise of the research vessel, AKADEMIK KURCHATOV. This volume contains several articles dealing with meteorological conditions, thermohaline mesostructure, structure of currents at the equator, equatorial upwelling, optical characteristics of the waters in the upwelling region, distribution of nutrients, organic substances and particulate matter, bioluminescence of the plankton and other related topics.

344. Viollier, M., D. Tandre, and P. Y. Deschamps (1980). An Algorithm for Remote Sensing of Water Color from Space. Boundary Layer Meteorology (18), 247-267.

The ocean color algorithm proposed in this paper takes into account the effects of Rayleigh and aerosol scattering. The inherent reflectance and the diffuse transmittance of the Rayleigh atmosphere are expressed as functions of optical thickness and satellite measurement geometry with the aid of simple and accurate formulas.

345. Visser, M. P. (1967). Secchi Disc and Sea Color Observations in the North Atlantic Ocean During the NAVADO III cruise, 1964-65, aboard H. Neth. M.S. SNELLIUS (Royal Netherlands Navy). Netherlands J. Sea Res. (3:4), 553-563.

During the Navado III cruise of H. Neth. M.S. SNELLIUS in the North Atlantic, 1964-65, observations on water transparency and color were made by means of Secchi discs of different diameter and a Forel scale. The influence of wave-action on the visibility of the Secchi disc is calculated in an approximative way. A fair relationship is found for the observed secchi depth and the corresponding percentage yellow in the Forel color-scale.

346. Visser, M. P. (1969). On the Light Regime of the Southern North Sea. International Council for the Exploration of the Sea, C.M. 1969/C:2, Hydrography Committee.

Based on existing data on Secchi disc visibility and (surface) measurements of beam attenuation mean values of these quantities have been computed for the southern North Sea for the periods December-May and June-November. From this material combined with data on vertical attenuation it has been tried to develop an approximated depth of the 1% level of daylight penetration. Cites a number of data sources.

347. Voitov, V. I. (1965). Water Transparency in the Eastern Part of the Indian Ocean During the Summer Monsoon Period. Investigations in Hydrooptics. In: Institut. Okeanologii Trudy (77), 92-97.

348. Voitov, V. I. (1974). Hydrophysical and Hydrooptical Investigations in the Atlantic and Pacific Oceans. Chapter 6, 92-97. See Monin and Shifrin (Eds.).

Review of water transparency investigation results obtained in regions of operation of the fifth voyage of the scientific research ship DMITRIY MENDELYEV.

349. Voitov, V. I. (1967). Some Results of an Expedition on the R/V AKADEMIK. S. Var. Hor. in the Red Sea and the Mediterranean. Oceanology (7:2), 271-276, Feb. (Trans. of Okeanologi (7:2), 1967, Amer. Geophys. U.).

350. Voitov, V. I. and M. G. Dement'yeva (1970). The Relative Transparency of the Indian Ocean Water. Oceanography (10:1), 35-37.

Observational data on the depth visibility of a white Secchi disk, obtained for the most part in recent years, were used to plot a chart of relative water transparency for the northern part of the Indian Ocean and its Antarctic waters. Relative transparency is analyzed as a function of plankton concentration, and the relation between the distribution of relative transparency and surface water circulation is examined.

351. Voitov, V. I. and O. V. Kopelevich (1971). Investigation of the Waters of the Ocean and Lagoons. Loc. cit. Referativnyy Zhurnal, Geofizika, 1972, No. 2.

Optical investigations in the western part of the Pacific Ocean, and Bay of Kiet (Salomon Island), Butaritari Atoll Lagoon, and Taraua Lagoon.

352. Voitov, V. I. and A. I. Ioffe (1976). A Method for the Description of Hydro-optical Fields in the Ocean. Okeanoloyiya (16:3), 524-527.

Analytical methods are used for the description of the light attenuation field. The employment of the model facilitates the determination of the value of the field at any point of the considered sea area.

353. Voitov, V. I., E. N. Khalemsky, and M. A. Shmatko (1976). Optical Properties of the Waters of the East China, South China and Java Seas. Oceanology (15:6), 657-658.

354. Vranski, V. K. and P. K. Markov (1947). Bibliography of the Publications on the Color, Transparency, and Penetration of Daylight into Natural Waters. Varna, Bulgaria. Chernomorska Biologichna Stantisiia, Trudove, No. 13, 37-65.

A list of 317 publications on color and transparency published between 1760 and 1947, with author and journals given. The investigations on the color and the transparency of natural waters and on the penetration of daylight has increased enormously during the last ten years and deal with problems, which are of interest for the biologists as well as for physicists and other engaged on oceanographical research. The results therefore are published in scientific periodicals of different kind, mainly biological, botanical, oceanographical, geophysical, geographical and etc [sic]. According to our knowledge a completless [sic] of publications dealing with this subject does not exist and we therefore compile a bibliography hoping it may prove useful for those interested in this branch of researches [sic]. The list comprises papers as well as books dealing partially or as a whole with the following problems, concerning the optics of the natural waters (sweet and salt waters): 1. Transparency of natural waters, investigations made on the spot or under laboratory conditions. 2. Penetration of daylight into natural waters. 3. Color of natural waters. 4. Theory of absorption and diffusion of light by natural waters. 5. Experimental methods and apparatus.

355. Williams, J., E. R. F. Johnson, and A. C. Dyer (1960). Water Transparency Observations Along the East Coast of North America. Smithsonian Miscellaneous Collections (139:10), October, 26 p.

356. Williams, R. G. (1969). Physical Oceanography of Block Island Sound. Navy Underwater Sound Lab., New London, Conn., USL-966, 56 p.

Block Island Sound (BIS), which has a mean depth of about 40 meters, has features common to both a tidal estuary and the offshore waters of the continental shelf. It has access to the sea through two broad channels and access to Long Island Sound through two narrow channels. In winter, the water is well mixed and of low temperature (1C - 3C). In summer, a thermocline develops, such that surface temperature is 20°C, while bottom temperature may be as low as 10°C. Surface salinity is about 29.00 salinity near the Race and almost 33.00 salinity near Block Island. Relatively large horizontal gradients of temperature and salinity are possible in BIS. Typical winter and summer sound-velocity profiles are presented, as well as information on density, stability, optical transparency, and currents. The currents are shown to be predominantly tidal with the semidiurnal component the most important. Current speeds approach 5 knots in the Race and decrease to 0.5 knot near Block Island. The report concludes with recommendations for future research and the proposal of a measuring program that uses moored oceanographic buoys, or towers, ships, and aircraft.

357. Williams, Jerome (1970). Optical Properties of the Sea. United States Naval Institute Series in Oceanography, U. S. Naval Institute, Annapolis, Md., 123 p.

Topics covered are the electromagnetic spectrum, radiation laws, solar radiation, radiometry and photometry, the effect of the hydrosphere on light (reflectance, absorption, scattering, extinction, attenuation, and beam transmittance), the mathematical model for suspended particulate matter, the visual threshold of the eye, the Secchi disc, viewing submerged objects from above and beneath the surface, forecasting water clarity and turbidity, and an analysis and critique of the more popular optical instruments.

358. Yentsch, C. S. (1960). The Influence of Phytoplankton Pigments on the Color of Sea Water. Deep Sea Res. (7), 1-9.

It is observed that as the concentration of phytoplankton pigments increases, the diminution of blue light gradually shifts the wavelength of maximum transmission toward the green. At the concentration of phytoplankton pigments normally found in the open ocean, the red chlorophyll band has little influence on water color. Inadequacies in present methods for detection of absorption bands in natural waters is attributed to wide bandwidths of filters used in submarine photometers. Improvements for spectral analysis are suggested.

359. Yentsch, C. S. (1962). Measurement of Visible Light Absorption by Particulate Matter in the Ocean. Limnol. and Oceanog. (7:2), 207-217.

Optical arrangements have been devised for the measurement of visible light absorption by particles in sea water. Spectral curves for particulate matter in the oceans have been obtained. These curves show pigment banding in the upper 100 m of water characteristics of absorption by chloroplastic pigments. Below this depth the absorption of particulate matter is characterized by a gradual increasing attenuation from long to short wavelengths. The nature of sea water particulate matter is discussed in terms of its absorbing characteristics and phytoplankton ecology.

360. Yeske, Lanny A. and Richard D. Waer (1968). The Correlation of Oceanic Parameters with Light Attenuation in Monterey Bay, California. M.S. Thesis, Naval Postgraduate School, Monterey, Calif., December 1968, 143 p.

An investigation of the correlation of oceanic parameters with light attenuation in Monterey Bay, California, was conducted during July and August 1968. Measurements of beam transmittance, salinity, temperature, density, and particulate matter, related in time and depth, were obtained during four cruises. Nearly 400 water samples were taken from two stations at depths between 0 and 85 m. Temperature showed the greatest correlation with beam transmittance. Isopycnals and beam transmittance contours showed a similar good correlation. Although salinity correlations were not clearly defined, isolated salinity pockets often appeared to be associated with transmissivity perturbations. A nearly linear relationship between values of particulate count and beam transmittance was observed. Particle sizes were found to decrease with increased depth. Approximately 96 percent of the particles affecting beam transmittance were less than 13 μ in diameter. Beam transmittance isolines generally oscillate with a tidal cycle period, the minimum values usually occurring at low tide. A possible correlation between lunar period, tidal ranges, and turbidity layers were indicated.

361. York, G. L. (1974). Statistical Studies of World-Wide Secchi Data. M. S. Thesis, U. S. Naval Postgraduate School, Monterey, Calif., 150 p.

362. Zaneveld, Andrade, Beardsley (1969). Measurement of Optical Properties at a Front Near Galapagos Islands. J. Geophys. Res. (74:23), 5540-5541.

363. Zaneveld, J. R., et al. (1978). Optical Hydrographic and Chemical Observations in the Monterey Bay area during May and September 1977. Oregon State University, School of Oceanography Ref. 78-13.

364. Zenkevich, L. (1963). Biology of the Seas of the USSR. Transl. by S. Botcharskaya, Interscience Publication.

This book describes the different water masses found near or within the boundaries of the Soviet Union. Salinity, temperature, and fauna distribution are given. A list is given of institutions that are carrying on research on the marine flora and fauna in the USSR. Publications dealing with the same subject are also listed along with their years of publications.

365. Zdanovich, V. G., I. V. Semenchenko, N. S. Ramm, Yu. D. Sharikov, and A. M. Kuzina (1967). Application of Aeromethods for Investigation of the Ocean. Foreign Technology Div., Wright-Patterson AFB, Ohio, FTD-MT-64-347, 675 p. Edited machine Trans. of Mono. Primenenie Aerometodov dlya Issledovaniya Morya. Moscow/Leningrad, 1963, P1-546.

The book illuminates the application of aerial techniques in oceanologic and hydrographic investigations. Questions of aerial photography of the sea and the aerial survey process are examined and the existing aeromethods for studying ocean waves and currents and for determing the depths and mapping of ocean shallows are considered in detail. Electronic equipment and the methods of its application for measurement of spectral

brightness of the sea from an aircraft are described. The publication is intended for photogrammetrists, hydrographers, and oceanologists occupied in the development and application of aeromethods for investigation of the oceans. The authors have generalized the results of works on the development and application of aeromethods in investigations of the ocean carried out mainly in the Laboratory of Aeromethods of the Academy of Sciences of the USSR. This latter circumstance has, to a considerable degree, determined the content and structure of the monograph, which therefore embraces only a part of the problems related to the considered region. Basic attention in the book is allotted to the methodology of studying ocean waves and currents, determining depth, charting shoal water, and measuring the spectral brightness of the sea.

GEOGRAPHICAL LISTING:

I. WORLD OCEANS

II. ATLANTIC

- A. General
- B. Northwest Atlantic
  1. Gulf of Mexico
  2. Florida Coast
  3. West Indies Waters
  4. Gulf Stream
  5. Chesapeake Bay
  6. New York Bight
  7. New England Coast
  8. Sargasso Sea
  9. Great Lakes
- C. Northeast Atlantic
  1. Norwegian Sea
  2. Baltic Sea
  3. North and Irish Sea
  4. Mediterranean Sea
- D. South Atlantic
  1. West African Coasts

III. PACIFIC

- A. General
- B. Northeast Pacific
  1. Alaska Coast
  2. California Coast
  3. Northeast/Canada Coast
- C. Central Pacific (Hawaii)
- D. Western Pacific
  1. General
  2. Japan Sea
  3. China Sea
  4. Asian Waters
- E. South Pacific
  1. General
  2. Australian Waters

IV. INDIAN OCEAN

- A. General
- B. Red Sea
- C. East African Coast

V. ARCTIC OCEAN

VI. ANTARCTIC OCEAN

VII. BLACK SEA

VIII. RELATED MARINE OPTICS RESEARCH STUDIES

I. WORLD OCEANS

18: Austin, R. W. and T. J. Petzold (1980).
36: Brown, P. J. (1973).
61: Environmental Planning Study (Strategic Straits)(U)(1947-1980).
70: Frederick, Margaret A. (1970).
91: Hickman, G. D. (1979).
118: Jerlov, N. G. and E. Steeman Nielsen (eds.)(1974).
120: Jerlov, N. G. (1976).
130: Kadishevich, E. A., Yu. S. Lyubovkeva, and V. M. Pavlov (1976).
149: Karabashev, G. S., A. N. Solov'yev, and K. P. Zangalis (1974).
152: Keating, J. H. (1966).
178: Lepley, L. K. (1968).
190: Matsuike, Kanau (1969).
199: Mine Warfare Pilot. Special Publications, 800-900 Series.
206: Morel, A. L. (1974).
217: Mullamaa, Yu. A. R. (1964).
219: National Oceanographic Data Center, Washington, D.C. (1974).
226: Neuymin, G. G., A. N. Paramonov, Ye. A. Agafonov, and S. V. Karaush (1966).
241: Opalski, M. A. (1963).
297: Shifrin, K. S. (ed.)(1975).
315: Stromer, Peter R. (1963).
320: Thorndike, E. M. and Maurice Ewing (1967).
329: Tucker, S. P. (1980).
331: Tucker, S. P. (1979).
342: Van Norden, Maxim F. (1979).
348: Voitov, V. I. (1974).
354: Vranski, V. K. and P. K. Markov (1947).
361: York, G. L. (1974).
364: Zenkevich, L. (1963).
365: Zdanovich, V. G., I. V. Semenchenko, N. S. Ramm, Yu. D. Sharikov, and A. M. Kuzina (1967).

II. ATLANTIC

A. General

45: Clarke, G. L. (1941).
50: Clark, Dennis (1980).
99: Hornig, A. W. and D. Eastwood (1973).
101: Hurlbert, E. O. (1945).
102: International Commission for the Northwest Atlantic Fisheries (1968).
105: Jacobs, M. B. and M. Ewing (1969).
113: Jerlov, N. G. (1961).
114: Jerlov, Nilo G. (1961).
116: Jerlov, N. G. (1961).
127: Joseph, J. (1959).
128: Joseph, J. (1961).
145: Karabashev, G. S., A. N. Solov'yev, and V. V. Yakubovich (1974).
146: Karabashev, G. S., A. N. Solov'yev, and V. V. Yakubovich (1974).
149: Karabashev, G. S., A. N. Solov'yev, and K. P. Zangalis (1974).
154: Ketchum, B. H. and D. H. Shonting (1958).
188: Matlack, D. E. (1971).
200: Monin, A. C. and K. S. Shifrin (1974).
223: Neuymin, G. G., N. A. Sorokina, A. N. Paramonov, and V. N Proschchin (1964).

228: Neuymin, G. G., Yu. A. Anikin, and N. A. Sorokina (1968).
230: Neuymin, G. G. and N. A. Sorokina (1976).
244: Oster, R. H. and G. L. Clarke (1935).
276: Ruhlmann, H. K. (1967).
277: Ruhlmann, H. K. and L. J. Tree (1968).
305: Sorokina, N. A., G. G. Neuymin, A. I. Yermolenko, and R. K. Timokhina (1974).
306: Sorokina, N. A. (1975).
307: Spilhaus, A. F., Jr. (1965).
308: Spilhaus, A. F., Jr. and W. S. von Arx (1966).
313: Stentz, D. A. (1975).
320: Thorndike, E. M. and Maurice Ewing (1967).
345: Visser, M. P. (1967).
348: Voitov, V. I. (1974).

B. Northwest Atlantic

1. Gulf of Mexico

6: Arnone, R. and R. Holyer (1973).
8: Atwell, B. H. (1976).
17: Austin, R. W. (1980).
24: Barrett, B. B. (1971).
25: Barrett, B. B., et al. (1978).
31: Berryhill, H. L., Jr., et al. (1978).
40: Carder, K. L. and K. D. Haddad (1979).
43: Clarke, G. L. (1937-38).
49: Clark, Dennis K., Edward T. Baker, and Alan E. Stroney (1980).
50: Clark, Dennis (1980).
62: Environmental Protection Agency, STORET Data Base.
79: Gordon, Howard R. and Dennis K. Clark (1980).
87: Heavers, R. M. (1967).
99: Hornig, A. W. and D. Eastwood (1973).
105: Jacobs, M. B. and M. Ewing (1969).
141: Kamykowski, D., et al. (1978).
186: Manheim, F. T., R. G. Steward, and K. L. Carder (1976).
191: Maul, G. A. and H. R. Gordon (1975).
194: McGrail, D. W., D. Huff, and S. Jenkins (1978).
215: Murdock, John (1980).
291: Scruton, P. C. and D. G. Moore (1953).
302: Smith, Raymond C. and Karen S. Baker (1978).
314: Stromer, Peter R. (1963).
319: Texas Natural Resources Information Systems.

2. Florida Coast

3: Arnone, R. A. (1978).
4: Arnone, Robert A. (1977).
5. Arnone, Robert and Gary G. Salsman (1977).
40: Carder, K. L. and K. D. Haddad (1979).
54: Dera, Jerry and Howard R. Gordon (1968).
62: Environmental Protection Agency, STORET Data Base.
65: Faller, K. H. (1974).
76: Godcharles, M. F. and W. C. Jaap (1973).
77: Gordon, H. R. and J. Dera (1969).
129: Joyce, E. A. and J. Williams (1969).

159: Kinney, Jo Ann S., S. M. Luria, and Donald O. Weitzman (1967).
168: Krumboltz, H. (1979).
186: Manheim, F. T., R. G. Steward, and K. L. Carder (1976).
192: Mayor, Lester G. and Robert N. Swift (1975).
202: Moore, H. B., H. Owre, E. C. Jones, and T. Dow (1953).
220: National Oceanographic Office (1975).
269: Prettyman, C. E. and W. G. Swarner (1968).
270: Prettyman, C. E. and M. O. Cermak (1969).
273: Reinhardt, George W. (1968).
281: Saloman, C. H. (1974).
282: Saloman, C. H. and L. A. Collins (1974).
324: Tolbert, W. H. (1959).

3. West Indies Waters

28: Barwick, A. S. (1969).
29: Barwick, A. S. (1969).
43: Clarke, G. L. (1937-38).
54: Dera, Jerry and Howard R. Gordon (1968).
63: Ewing, G. C. (1973).
77: Gordon, H. R. and J. Dera (1969).
105: Jacobs, M. B. and M. Ewing (1969).
119: Jerlov, N. G. (1974).
144: Karabashev, G. S. and A. N. Solov'yev (1974).
153: Kelly, Mahlon G. (1968).
154: Ketchum, B. H. and D. H. Shonting (1958).
180: Li, M. Ye. and O. V. Martynov (1976).
209: Morel, Andre (1980).
230: Neuymin, G. G. and N. A. Sorokina (1976).
256: Petzold, Theodore J. (1977).
262: Polcyn, F. C. and D. R. Lyzenga (1973).
305: Sorokina, N. A., G. G. Neuymin, A. I. Yermolenko, and R. K. Timokhina (1974).
306: Sorokina, N. A. (1975).
313: Stentz, D. A. (1975).
335: Tyler, John E. (1968).
339: Utterback, C. L. and J. Watson Boyle (1933).

4. Gulf Stream

46: Clarke, G. L. and Charles J. Hubbard (1959).
48: Clarke, G. L. and Gifford C. Ewing (1974).
57: Egan, W. G. (1974).
58: El-Sayed, S. Z. (1974).
64: Ewing, G. C. (1965).
104: Ivanoff, Alexandre, Nilo Jerlov, and Talbot H. Waterman (1961).
137: Kampa, E. M. (1961).
145: Karabashev, G. S., A. N. Solov'yev, and V. V. Yakubovich (1974).
185: Manheim, Frank T. and Robert H. Meade (1970).
191: Maul, G. A. and H. R. Gordon (1975).
193: McCluney, W. R. (1974).
267: Powers, C. F., E. E. Deulber, Jr., and R. H. Backus (1952).
273: Reinhardt, George W. (1968).
290: Schubel, J. R. (1969).
309: Spilhaus, A. F., Jr. (1968).

310: Stamm, Gordon L. and Robert A. Langel (1961).
336: Tyler, John E. and Raymond C. Smith (1970).
355: Williams, J., E. R. F. Johnson, and A. C. Dyer (1960).

5. Chesapeake Bay

37: Burt, Wayne V. (1953).
38: Burt, Wayne V. (1955).
66: Fleischer, P., D. E. Bowker, W. G. Witte, T. A. Gosink, W. J. Hanna, and J. C. Ludwick (1976).
67: Flemer, D. A. (1969).
79: Gordon, Howard R. and Dennis K. Clark (1980).
101: Hurlbert, E. O. (1945).
106: Jarrett, O., Jr., P. B. Mumola, and C. A. Brown, Jr. (1973).
120: Jerlov, N. G. (1976).
311: Stamm, G. L., C. F. Wingquist, et al. (1966).
316: Stroup, E. D. and Judith Wood (1966).
355: Williams, J., E. R. F. Johnson, and A. C. Dyer (1960).

6. New York Bight

43: Clarke, G. L. (1937-38).
44: Clarke, G. L. and Harry R. James (1939).
83: Grew, Gary W. (1976).
121: Johnson, Robert W. (1978).
159: Kinney, Jo Ann S., S. M. Luria, and Donald O. Weitzman (1967).
185: Manheim, Frank T. and Robert H. Meade (1970).
211: Morrison, Robert E. (1967).
212: Morrison, R. E. (1968).
213: Morrison, R. E. (1970).
214: Morrison, R. (1970).
267: Powers, C. F., E. E. Deulber, Jr., and R. H. Backus (1952).
274: Riley, G. A. (1956).
342: Van Norden, Maxim F. (1979).
355: Williams, J., E. R. F. Johnson, and A. C. Dyer (1960).
356: Williams, R. G. (1969).

7. New England Coasts

44: Clarke, G. L. and Harry R. James (1939).
47: Clarke, George L. (1968).
48: Clarke, G. L. and Gifford C. Ewing (1974).
64: Ewing, G. C. (1965).
119: Jerlov, N. G. (1974).
185: Manheim, Frank T. and Robert H. Meade (1970).
230: Neuymin, G. G. and N. A. Sorokina (1976).
244: Oster, R. H. and G. L. Clarke (1935).
266: Powell, Wilson M. and George L Clarke (1936).
307: Spilhaus, A. F., Jr. (1965).
308: Spilhaus, A. F., Jr. and W. S. von Arx (1966).
342: Van Norden, Maxim F. (1979).
355: Williams, J., E. R. F. Johnson, and A. C. Dyer (1960).

8. Sargasso Sea

44: Clarke, G. L. and Harry R. James (1939).
119: Jerlov, N. G. (1974).
137: Kampa, E. M. (1961).
144: Karabashev, G. S. and A. N. Solov'yev (1974).
170: Kullenberg, Gunnar (1968).
172: Kullenberg, G., B. Lundgren, S. Malmberg, K. Nygard, and N. Hojerslev (1970).
173: Kullenberg, G., B. Lundgren, A. A. Malmberg, K. Nygard, and N. Hojerslev (1974).
180: Li, M. Ye. and O. V. Martynov (1976).
193: McCluney, W. R. (1974).
207: Morel, Andre and Louis Prieur (1977).
230: Neuymin, G. G. and N. A. Sorokina (1976).
244: Oster, R. H. and G. L. Clarke (1935).
302: Smith, Raymond C. and Karen S. Baker (1978).
309: Spilhaus, A. F., Jr. (1968).

9. Great Lakes

182: Lyzenga, David (1980).
195: McNeil, W. R. and K. P. B. Thomson (1974).
218: Munday, J. C., Jr. (1974).
258: Pinsak, A. P. (1967).
262: Polcyn, F. C. and D. R. Lyzenga (1973).

C. <u>Northeast Atlantic</u>

1. *Norwegian Sea*

2: Armstrong, F. A. J. and G. T. Boalch (1961).
64: Ewing, G. C. (1965).
86: Halldal, Per (1974).
96: Hojerslev, N. K. and B. Lundgren (1977).
126: Joseph, Joachim (1959).
127: Joseph, J. (1959).
128: Joseph, J. (1961).
138: Kampa, E. M. (1970).
157: Kielhorn, W. V. (1952).
169: Kullenberg, G. (1967).
179: Levring, Tore (1965).
196: Medvedev, V. S. and N. M. Krivonosova (1964).
223: Neuymin, G. G., N. A. Sorokina, A. N. Paramonov, and V. N. Proschchin (1964).
225: Neuymin, G. G., A. N. Paramonov, Ye. A. Agafonov, and S. V. Karaush (1966).
231: Nielsen, J. H. and E. Aas (1977).
238: Oceanology No. 2 (1973).
252: Paramonov, A. N., G. G. Neuymin, and V. V. Efimov (1966).
345: Visser, M. P. (1967).

2. Baltic Sea

32: Bladh, J. O. (1972)
68: Fonds, J. and D. Eisma (1967).
93: Hojerslev, N. K. (1980).
95: Hojerslev, N. K. (1974).

108: Jerlov, N. G. (1953).
109: Jerlov, N. G. (1955).
117: Jerlov, N. G. and K. Nygard (1968).
119: Jerlov, N. G. (1974).
124: Joseph, Joachim (1950).
142: Karabashev, G. S., K. P. Zangalis, A. N Solov'yev, and V. V. Yakubovich (1971).
143: Karabashev, G. S. and K. P. Zangalis (1971).
171: Kullenberg, Gunnar (1969).
252: Paramonov, A. N., G. G. Neuymin, and V. V. Efimov (1966).

3. North and Irish Sea

1: Armstrong, F. A. J. and G. T. Boalch (1961).
2: Armstrong, F. A. J. and G. T. Boalch (1961).
55: Doerffer, Roland (1980).
56: Duursma, E. K. (1974).
64: Ewing, G. C. (1964).
69: Foster, P., G. Savidge, G. M. Foster, D. T. E. Hunt, and K. B. Pugh (1976).
71: Fry, E., Texas A&M College Station, Personal Communication.
88: Heathershaw, D. C. and J. H. Simpson (1974).
89: Hemmings, C. C. (1965).
90: Hickel, W., E. Hagmeier, and G. Drebes (1971).
93: Hojerslev, N. K. (1980).
97: Hojerslev, N. K. (1978).
120: Jerlov, N. G. (1976).
123: Joseph, Joachim (1950).
125: Joseph, J. (1953).
132: Kalle, Kurt (1937).
133: Kalle, Kurt (1953).
138: Kampa, E. M. (1970).
159: Kinney, Jo Ann S., S. M. Luria, and Donald O. Weitzman (1967).
204: Morel, Andre (1965).
245: Otto, L. (1966).
246: Otto, L. (1967).
257: Pickard, G. L. and L. F. Giovando (1960).
263: Postma, Von H. and K. Kalle (1955).
272: Ray, I. A. and K. Bondar (1967).
317: Sugihara, S. (1969).
346: Visser, M. P. (1969).

4. Mediterranean Sea

18: Austin, R. W. and T. J. Petzold (1980).
27: Bauer, D. and A. Morel (1967).
29: Barwick, A. S. (1969).
35: Boulter, Jacques (1971).
42: Carlson, Quick and Timothy McBride (1978).
56: Duursma, E. K. (1974).
63: Ewing, G. C. (1973).
94: Hojerslev, N. K. (1973).
110: Jerlov, N. G. (1958).
111: Jerlov, N. G. and Jacques Piccard (1959).
112: Jerlov, N. G. and M. Fukuda (1960).
119: Jerlov, N. G. (1974).

137: Kampa, E. M. (1961).
177: LeNoble, Jacqueline (1955).
179: Levring, Tore (1965).
180: Li, M. Ye. and O. V. Martynov (1976).
201: Moore, H. B. (1949).
204: Morel, Andre (1965).
209: Morel, Andre (1980).
232: Nikolayev, V. P. and A. A. Zhil'tsov (1959).
349: Viotov, V. I. (1967).

D. South Atlantic

1. West African Coasts

84: Grindley, J. R. and F. J. R. Taylor (1970).
116: Jerlov, N. G. (1961).
140: Kampa, E. M. (1976).
162: Kohnke, D. (1969).
180: Li, M. Ye. and O. V. Martynov (1976).
293: Shannon, J. G. (1978).

III. PACIFIC

A. General

10: Austin, R. W. and J. M. Hood, Jr. (1966).
30: Beardsley, G. F., Jr., R. T. Hodgson, J. R. V. Zaneveld, and R. I. Smith (1968).
39: Burt, W. V (1958).
41: Carder, Kendall L., G. F. Beardsley Jr., and Hasong Pak (1971).
75: Gilbert, Gary D. (1965).
82: Graham, J. J. (1970).
99: Hornig, A. W. and D. Eastwood (1973).
105: Jacobs, M. B. and M. Ewing (1969).
139: Kampa, E. M. (1970).
149: Karabashev, G. S., A. N. Solov'yev, and K. P. Zangalis (1974).
152: Keating, J. H. (1966).
155: Khalemsky, E. N. and V. I. Voitov (1972).
164: Kozlyaninov, M. V. and I. M. Orchinnikov (1961).
165: Kozlyaninov, M. V. (1961).
167: Krishnan, K. S., R. C. Honey, W. E. Evans, and G. P. Sorenson (1969).
174: Kumagori, T., K. Kagata, and H. Suzuki (1958).
187: Man'kowskiy, V. I. (1973).
197: Merrifield, Roger (1964).
200: Monin, A. C. and K. S. Shifrin (1974).
209: Morel, Andre (1980).
235: Nishizawa, S., N. Inoue, and T. Akiba (1959).
253: Patsifiki Vedernikov, V. L., O. I. Koblentz-Mishke, I. N. Sukhanova, G. S. Karabashev, and Ya. Fisher (1975).
278: Rutkovskaya, V. A. and B. V. Konovalov (1972).
302: Smith, Raymond C. and Karen S. Baker (1978).
318: Sysoev, N. N. (1969).
320: Thorndike, E. M. and Maurice Ewing (1967).
340: Utterback, C. L. and W. Jorgensen (1934).

343: Vinogradov, K. E. (Chief Editor)(1975).
348: Voitov, V. I. (1974).
362: Zaneveld, Andrade, Beardsley (1969).

B. <u>Northeast Pacific</u>

1. Alaska Coast

7: Arsen'yev, V. S. and V. I. Voitov (1968).
80: Gower, J. F. R. (1980).
82: Graham, J. J. (1970).
164: Kozlyaninov, M. V. and I. M. Orchinnikov (1961).
165: Kozlyaninov, M. V. (1961).
181: Likens, Gene E. and Philip L. Johnson (1968).
340: Utterback, C. L. and W. Jorgensen (1934).

2. California Coasts

11: Austin, R. W. (1972).
12: Austin, R. W. (1973).
13: Austin, R. W. (1974).
15: Austin, R. W. and R. L. Ensminger (1978).
20: Baker, R. E. (1970).
21: Bakun, A. (1975).
23: Barham, E. G., J. W. Wilton, and M. P. Sullivan (1966).
26: Bassett, Charles H. and Harry C. Furminger (1965).
34: Boden, B. P., E. M. Kampa, and J. M. Snodgrass (1961).
50: Clark, Dennis (1980).
51: Crews, Thomas W. (1971).
53: DeFalco, Paul Jr., Robert J. Pafford, Jr., and John R. Teerink (1971).
59: Emery, K. O. (1954).
64: Ewing, G. C. (1965).
73: Gilbert, G. D. and R. O. Rue (1967).
74: Gilbert, Gary (1968).
75: Gilbert, Gary D. (1965).
77: Gordon, H. R. and J. Dera (1969).
79: Gordon, Howard R. and Dennis K. Clark (1980).
98: Holmes, R. W. (1970).
100: Hughes, R. S. and R. W. Austin (1965).
136: Kampa, E. M. and B. Boden (1957).
137: Kampa, E. M. (1961).
139: Kampa, E. M. (1970).
151: Kazanowska, Maria (1971).
156: Kiefer, Dale A. and R. W. Austin (1974).
158: Kinder, Floyd A. (1966).
175: Labyak, Peter S. (1969).
198: Michelini, R. T. (1971).
215: Murdock, John H. (1980).
216: Mueller, J. L. (1976).
236: Nygard K. (1968).
239: Ochakovskiy, Yu. Ye. and A. S. Suslyayev (1968).
243: Oser, R. K., J. L. Berger, and Louis J. Franc (1967).
256: Petzold, Theodore J. (1977).
265: Potts, John (1971).

294: Shepard, Authur B. (1970).
300: Smith, Raymond C. and John E. Tyler (1968).
302: Smith, Raymond C. and Karen S. Baker (1978).
304: Soluri, E. A. (1971).
326: Tucker, Stevens P. and James Reese (1968).
327: Tucker, Stevens P., R. D. Waer, and L. A. Yeske (1969).
328: Tucker, S. P. and P. S. Labyak (1969).
330: Tucker, S. P. (1973).
333: Tyler, John E. (1965).
334: Tyler, J. E. and R. C. Smith (1967).
336: Tyler, John E. and Raymond C. Smith (1970).
360: Yeske, Lanny A. and Richard D. Waer (1968).
363: Zaneveld, J. R., et al. (1978).

3. Northeast/Canada Coasts

21: Bakun, A. (1975).
75: Gilbert, Gary D. (1965).
80: Gower, J. F. R. (1980).
139: Kampa, E. M. (1970).
164: Kozlyaninov, M. V. and I. M. Orchinnikov (1961).
165: Kozlyaninov, M. V. (1961).
184: Malmberg, Sv. A. (1964).
215: Murdock, John H. (1980).
216: Mueller, J. L. (1976).
247: Pak, Hasong (1969).
248: Pak, H. (1974).
249: Pak, H. and J. R. V. Zaneveld (1977).
250: Pak, H. and J. R. V. Zaneveld (1978).
298: Small, L. F. (1980).
299: Small, Lawrence F. and Herbert Curl, Jr. (1968).
302: Smith, Raymond C. and Karen S. Baker (1978).
333: Tyler, John E. (1965).

C. <u>Central Pacific (Hawaii)</u>

64: Ewing, G. C. (1965).
75: Gilbert, Gary D. (1965).
82: Graham, J. J. (1970).
163: Kozlyaninov, M. V. (1960).
302: Smith, Raymond C. and Karen S. Baker (1978).

D. <u>Western Pacific</u>

1. General

10: Austin, R. W. and J. M. Hood, Jr. (1966).
39: Burt, W. V. (1958).
41: Carder, Kendall L., G. F. Beardsley, Jr., and Hasong Pak (1971).
87: Heavers, R. M. (1967).
131: Kadishevich, E. A. and Yu. S. Lyubovkeva (1974).
163: Kozlyaninov, M. V. (1960).
174: Kumagori, T., K. Kagata, and H. Suzuki (1958).
180: Li, M. Ye. and O. V. Martynov (1976).
210: Morita, J. (1973).

235: Nishizawa, S., N. Inoue, and T. Akiba (1959).
283: Sasaki, T., N. Okami, E. Watanabe, and G. Oshiba (1955).
351: Voitov, V. I. and O. V. Kopelevich (1971).
353: Voitov, V. I., E. N. Khalemsky, and M. A. Shmatko (1976).

2. Japan Sea

18: Austin, R. W. and T. J. Petzold (1980).
87: Heavers, R. M. (1967).
92: Hishida, Kozo (1966).
189: Matsuike, Kanau (1968).
240: Ogura, Norio (1965).
275: Rokuro, Adachi (1972).
283: Sasaki, T., N. Okami, E. Watanabe, and G. Oshiba (1955).
284: Sasaki, T., N. Okami, S. Watanabe, and G. Oshiba (1957).
285: Sasaki, T., N. Okami, G. Oshiba, and S. Watanabe (1962).
286: Sasaki, Tadayoshi, Noboro Okami, and Setsuki Matsumura (1968).
287: Sasaki, T. and N. Okami (1968).
288: Sasaki, Tadayoshi, Gohachiro Oshiba, and Motoaki Kishino (1966).
351: Voitov, V. I. and O. V. Kopelevich (1971).
353: Voitov, V. I., E. N. Khalemsky, and M. A. Shmatko (1976).

3. China Sea

234: Nishizawa, Satoshi and Naoichi Inoue (1958).
283: Sasaki, T., N. Okami, E. Watanabe, and G. Oshiba (1955).
342: Van Norden, Maxim F. (1979).
351: Voitov, V. I. and O. V. Kopelevich (1971).
353: Voitov, V. I., E. N. Khalemsky, and M. A. Shmatko (1976).

4. Asian Waters

180: Li, M. Ye. and O. V. Martynov (1976).
215: Murdock, John H. (1980).
284: Sasaki, T., N. Okami, S. Watanabe, and G. Oshiba (1957).
342: Van Norden, Maxim F. (1979).
353: Voitov, V. I., E. N. Khalemsky, and M. A. Shmatko (1976).

E. South Pacific

1. General

39: Burt, W. V. (1958).
130: Kadishevich, E. A., Yu. S. Lyubovkeva, and V. M. Pavlov (1974).
131: Kadishevich, E. A. and Yu. S. Lyubovkeva (1974).
351: Voitov, V. I. and O. V. Kopelevich (1971).
353: Voitov, V. I., E. N. Khalemsky, and M. A. Shmatko (1976).

2. Australian Waters

160: Kirk, J. T. O. (1976).
324: Tressler, Willis L. (1961).

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A. General

64: Ewing, G. C. (1965).
105: Jacobs, M. B. and M. Ewing (1969).
148: Karabashev, G. S. (1975).
152: Keating, J. H. (1966).
174: Kumagori, T., K. Kagata, and H. Suzuki (1958).
176: LaFond, E. C. and J. Sivarama Sastry (1957).
180: Li, M. Ye. and O. V. Martynov (1976).
254: Pavlov, V. M. (1961).
279: Russell, H. D. and G. L. Clarke (1944).
296: Shifrin, K. S. and V. N. Pelevich (1975).
325: Tressler, Willis L. (1961).
347: Voitov, V. I. (1965).
350: Voitov, V. I. and M. G. Dement'yeva (1970).

B. Red Sea

180: Li, M. Ye. and O. V. Martynov (1976).
232: Nikolayev, V. P. and A. A. Zhil'tsov (1959).
349: Voitov, V. I. (1967).

C. East African Coast

64: Ewing, G. C. (1965).
148: Karabashev, G. S. (1975).
180: Li, M. Ye. and O. V. Martynov (1976).

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157: Kielhorn, W. V. (1952).
197: Merrifield, Roger (1964).
222: Neshyba, S., G. f. Beardsley, Jr., V. T. Neal, and K. Carder (1968).
320: Thorndike, E. M. and Maurice Ewing (1967).

VI. ANTARCTIC OCEAN

190: Matsuike, Kanau (1969).

VII. BLACK SEA

146: Karabashev, G. S., A. N. Solov'yev, and V. V. Yakubovich (1974).
180: Li, M. Ye. and O. V. Martynov (1976).
224: Neuymin, G. G. and A. N. Paramonov (1965).
227: Neuymin, G. G. and Yu. A. Anikin (1968).
228: Neuymin, G. G., Yu. A. Anikin, and N. A. Sorokina (1968).
229: Neuymin, G. G. (1973).
232: Nikolayev, V. P. and A. A. Zhil'tsov (1959).
233: Nikolayev, V. P., V. G. Yakubenko, A. A. Zhil'tsov, V. K. Tutobalin, V. M. Pavlov, and M. S. Zhulapov (1976).
251: Paramonov, A. N. (1965).
255: Pepita, T. S., M. I. Satina, and Ye. P. Delando (1960).
259: Pivevarov, A. A., E. P. Anisimova, and N. Erikova (1965).
321: Timofeyva, V. A. (1960).

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13: Austin, R. W. (1974).
14: Austin, R. W. and T. J. Petzold (1975).
15: Austin, R. W. and R. L. Ensminger (1978).
16: Austin, R. W., T. S. Petzold, R. C. Smith, and J. E. Tyler (1980).
19: Bailey, James S. and Peter G. White (1969).
22: Ball, T. F. and E. Lafond (1962).
33: Blanchard, B. J. and R. W. Leamer (1973).
42: Carlson, Quick and Timothy L. McBride (1978).
46: Clarke, G. L. and Charles J. Hubbard (1959).
52: Davis, P. W. (1965).
60: Environmental Research Institute of Michigan (1972).
63: Ewing, G. C. (1973).
71: Fry, E., Texas A&M College Station, Personel Communication.
78: Gordon, H. R. and A. W. Wonters (1978).
85: Gross, E. L. and S. H. Prasher (1974).
103: Isaacs, John D., Sargun O. Tont, and Gerald L. Wick (1974).
107: Jerlov, N. G. and B. Kullenberg (1953).
115: Jerlov, N. G. (ed.)(1961).
134: Kalle, K. (1961).
135: Kalle, K. (1966).
147: Karabashev, G. S. and A. N. Solov'yev (1974).
150: Kattawar, George W. and Gilbert R. Plass (1975).
161: Kobletz-Mishke, O. I. and Yu. E. Ochakovsky (1966).
166: Kozlyaninov, M. V. (ed.)(1965).
183: Lyzenga, D., R. Shuchman, C. Davis, and G. Suits (1979).
203: Moore, H. B. and E. G. Corwin (1956).
205: Morel, A. L. (1973).
206: Morel, A. L. (1974).
208: Morel, Andre and Howard R. Gordon (1980).
217: Mullamaa, Yu. A. R. (1964).
221: Nelepo, B. A., A. S. Lezhen, A. L. Kravtsov, and G. K. Korotayev (1977).
237: Oceanology No. 1 (1971).
242: Optics of the Sea (Interface and In-Water Transmission and Imaging)(1973).
260: Plass, Gilbert N. and George W. Kattawar (1969).
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264: Postma, H. (1961).
268: Preisendorfer, R. W. (1976).
271: Ramsey, Richard C. (1968).
280: Ryther, J. H. and C. S. Yentsch (1957).
295: Sherstyankin, P. P. (1972).
301: Smith, Raymond C. and Wayne H. Wilson, Jr. (1972).
303: Smith, R. C. and Karen S. Baker (1978).
312: Steeman, Nielsen E. (1975)
322: Timofeyva, V. A. (1962).
323: Timofeyva, V. A. and G. G. Neuymin (1968).
332: Tyler, John E. (1960).
335: Tyler, John E. (1968).
337: Tyler, J. E., R. W. Austin, and T. J. Petzold (1974).
338: Tyler, John E. (ed.)(1977).
344: Viollier, M., D. Tandre, and P. Y. Deschamps (1980).
352: Voitov, V. I. and A. I. Ioffe (1976).
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In support of the Defense Mapping Agency, a data base of available marine optical properties from throughout the world has been compiled in this annotated bibliography. This bibliography permits an assessment of amount and type of water optical data available and describes the limitations and problems associated with developing a marine optical data base.

DMA requires temporal coastal atlases of marine optical properties throughout the world. The data listed within the articles of this bibliography provide

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a reference for assessing atlas development. This data base will also provide ground truth for exploiting alternate technology; namely, remote sensing, to generated marine optics atlases.

From this bibliography, problems associated with establishing a marine optical data base are rapidly seen. Aside from the problem of data being unavailable from numerous ocean/coastal areas where optical measurements have not been made, the types of marine optic properties are numerous and cannot be correlated to form a common data base. Additionally, the temporal variability of marine optics has not been adequately studied and compounds the problem of establishing a world data base.

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